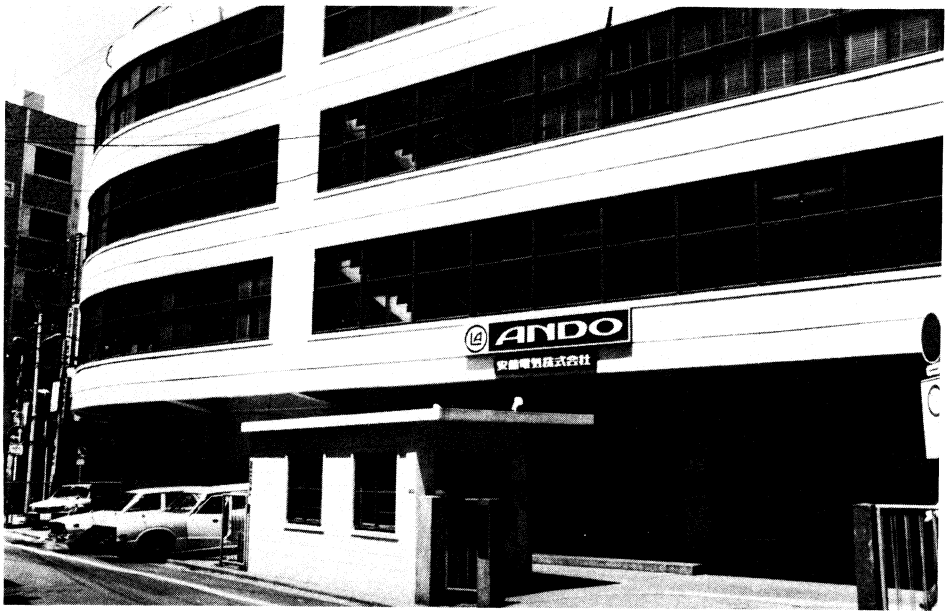
1981/82 ELECTRONIC MEASURING INSTRUMENTS

ANDO

ANDO ELECTRIC CO.,LTD.

OUTLINE OF ANDO ELECTRIC

Established:	June 29, 1933
Paid-up Capital:	¥654,640,000
President:	Shun-ichi Oshiro
Stock Exchange Listing:	Second Section, Tokyo Stock Exchange
Annual Gross Sales:	¥14,200 million (fiscal 1980)
Head Office:	19-7, Kamata 4-chome, Ota-ku, Tokyo
Osaka Branch Office:	Takahashi Bldg. Minamikan, 14-16, Nishi-Temma 3-chome, Osaka
Regional Sales Offices:	Kumamoto, Fukuoka, Hiroshima, Nagoya, Kosai, Sendai
Kosai Plant:	724, Washizu, Kosai, Shizuoka
Omori Center:	Nambu Bldg., 34-6, Chuo 3-chome, Ota-ku, Tokyo



Head Office

Kosai Plant

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SALES, SHIPMENTS & SERVICE INFORMATION

ORDER BY TYPE NUMBER

When ordering, please specify the catalog number and name of the instruments desired. For example, "Type AJ-2730 Frequency Synthesizer". To prevent misunderstanding, always include significant specifications. Whenever special options or features such as special colors, non-standard power line voltages, etc. are desired, include specific instructions.

CONDITIONS OF SALE

Determination of prices, terms and conditions of sale, and final acceptance of orders are made only at our office in Tokyo, Japan.

TERMS

Full payment in advance of shipment or by sight draft against an irrevocable letter of credit at a Tokyo bank.

QUOTATIONS AND PRO-FORMA INVOICES

FOB, CIF, C&F, etc. quotations and pro-forma invoices are available on request.

SURCHARGE

A surcharge applies to orders requiring certificates issued by an appropriate public authority or a duly qualified independent inspector.

SHIPMENTS

Shipments to customers are made by either surface or air, as desired.

WARRANTY

All Ando instruments are warranted against defective materials and workmanship. The warranty is effective for one year from the delivery date but not longer than 18 months after the original shipment.

REPAIR PARTS

When ordering repair parts, please describe the parts required completely, using symbol numbers and descriptions from the parts list, and giving the type numbers and serial numbers of the respective instruments.

RETURNING INSTRUMENTS FOR REPAIR

When returning instruments for repair, please ask for shipping instructions. Please state type numbers and serial numbers of the instruments and dates of purchases.

SPECIFICATION CHANGES

Ando reserves the right to discontinue any item without prior notice and to change designs, models or specifications at any time without incurring any obligation to incorporate new features in instruments or parts previously sold.

POWER-SUPPLY CONSIDERATIONS

AC operated instruments are wired for operation from 100V/50-60Hz, unless otherwise specified. However, optional power requirements such as 110V/50-60Hz, 220V/50-60Hz or 230V/50-60Hz can be met on request.

OVERALL DIMENSIONS

The overall dimensions of all instruments herein are expressed as height x width x depth in milimeters, and do not include knobs, fittings or stands.

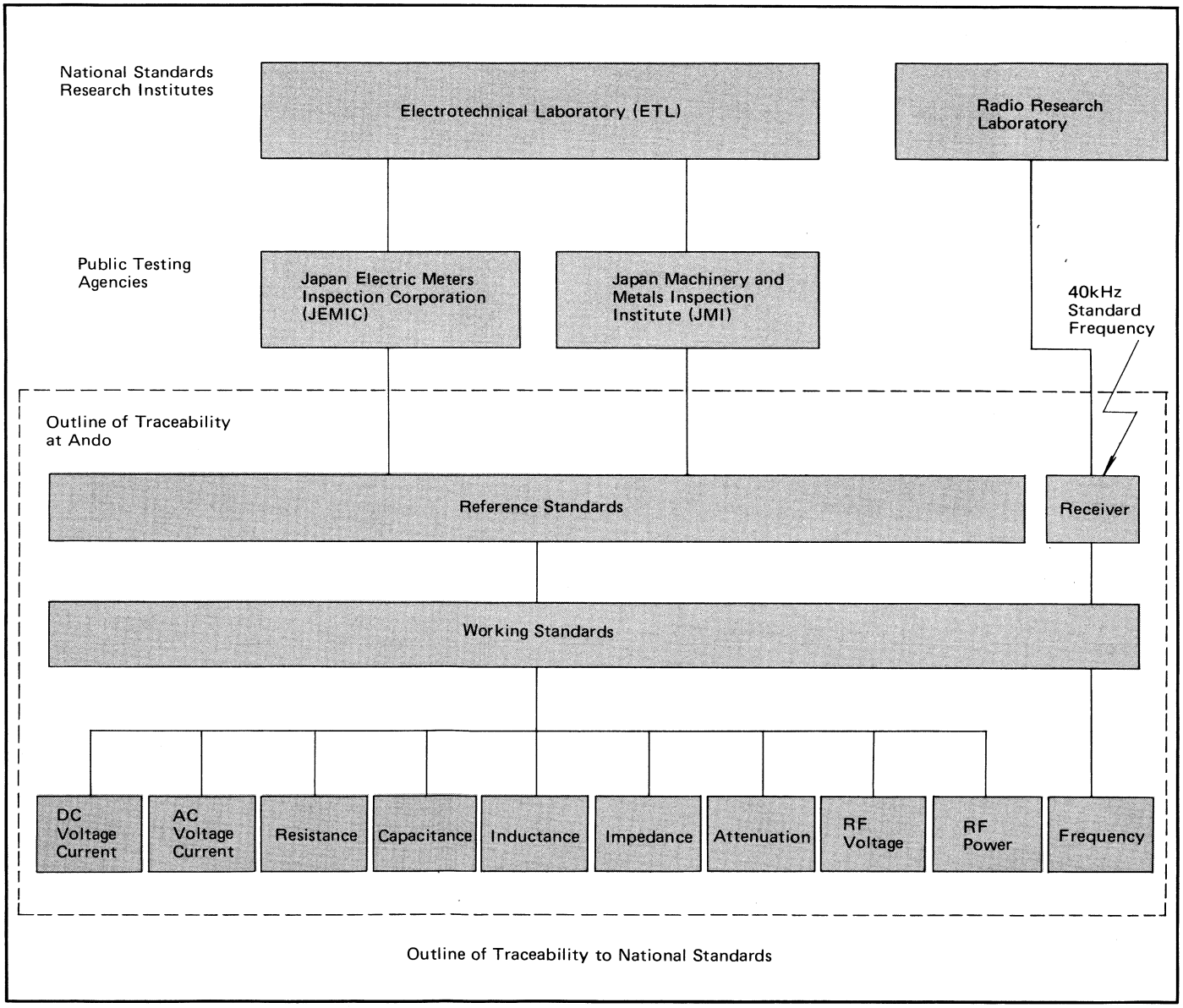
ANDO'S CALIBRATION SYSTEM—TRACEABILITY

Scientific technological progress is based on accurate measurements, while measuring instruments acquire increasing importance in many areas including production, research, safety management and control. Quality assurance is indispensable for these instruments, and their precision must be based on national standards. In other words, they must have established traceability.

"Traceability" is a simplified word of "traceability of measurement standard to national standards", and the traceability is "a function in which measurement standard of a measuring instrument must be calibrated properly through well cleared route and method step by step by more precise standards or instruments finally to a national standard".

- Ando's Calibration System

Ando maintains rigid controls for instruments used in production and inspection applications in accordance with the calibration system shown below. Ando performs calibrations in its own electric standards laboratory in which the temperature and humidity are perfectly controlled. Reference instruments are traceable to national standards over all ranges from DC to high frequencies and are stored in well-controlled conditions. Instruments manufactured by Ando are calibrated and checked against these reference instruments for increased precision and superb quality assurance.



Outline of Traceability to National Standards

A STANDARD INTERFACE BUS

The recent popularity of personal or desk-top computers has stimulated use of automatic measuring systems in various fields, primarily to reduce labor. The most critical problem in combining an automatic measuring system with programmable measuring equipment is how to optimize the interface. Various problems have arisen due to the lack of standardized interface systems. This has recently led to development of universally-accepted interface bus systems; the most popular is the GP-IB (IEEE-488) or IEC-IB system, details of which are discussed here.

INTRODUCTION

Interface can be defined as the set of unbreakable promises in exchanging signals between devices. Interface is normally based on the specifications of an element on the line connecting the devices. Such specifications include:

1) Mechanical specifications, mainly of the connectors;
2) Electrical specifications, such as signal voltage, current, and timing; and
3) Software specifications, such as procedures to send and receive signals.

Interfaces also may be classified by the method of digital signal transfer:

1) Byte-parallel, bit-parallel
   (Star connection, large number of lines)
2) Byte-serial, bit-parallel
   (Bus connection, limited number of lines)
3) Byte-serial, bit-serial
   (Bus connection, one or very few lines)

There are advantages and disadvantages to each of these methods. The best method must selected on the basis of the specific purpose of the interface.

Byte-Parallel, Bit-Parallel Interfaces

As shown in Fig. 1, this calls for parallel connection of all signal lines — each individual line is connected. The interface function is simple but the number of lines required is large.

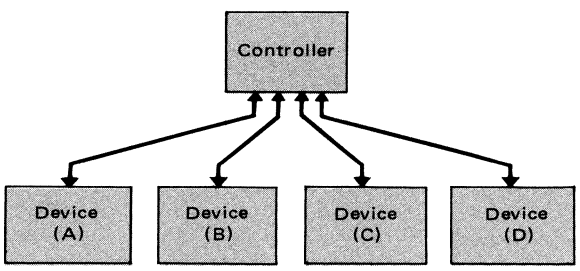
This interface is widely used for small-scale systems and for systems that require connection of components in a signal device or high-speed, real-time data transfer. Standardization of this interface system is difficult because number of connecting lines varies according to the type and quantity of data signals.

Byte-Serial, Bit-Parallel Interfaces

This system requires only eight data transfer lines because data is transferred in bytes (8 bits). A few more lines are required for control.

The main advantage of this system is ease of standardization, due to data handling in bytes. The system can handle any quantity of data with a relatively limited number of connecting lines, provided the data is divided into bytes prior to transfer. This system is becoming popular for peripheral equipment and programmable measuring equipment.

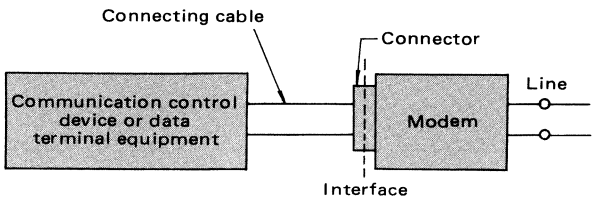
Fig. 1: Byte-parallel, bit-parallel interface



Byte-Serial, Bit-Serial Interfaces

This system transfers data by the bit and requires only one data transfer line. It is popular for systems that transfer data over relatively long distances. A representative system is the RS-232C serial interface shown in Fig. 2.

Fig. 2: RS-232C serial interface



GP-IB (General-Purpose Interface Bus)

Application Areas

- This standard is applicable to the interface of instrumentation systems, or portions of them, in which:
  - the data exchanged among the interconnected apparatus is digital (as distinct from analog);
  - the number of devices that may be interconnected by one contiguous bus does not exceed 15;
  - the total transmission path length over the interconnecting cables does not exceed 20m;
  - the data rate across the interface on any signal line does not exceed 1 megabit per second.
- This standard applies generally to laboratory and production test environments which are both electrically quiet and restricted as to physical dimensions (distances between the system components).

Interface System Overview

- Messages (quantities of information) carried by an interface system belong to either of two broad categories:
  - messages used to manage the interface system itself, hereinafter called interface messages;
  - messages used by the devices interconnected via the interface system that are carried by, but not used or processed by the interface system directly, hereinafter called device-dependent messages.

  Note — The detailed specification of device-dependent messages is beyond the scope of this standard.
- An effective communication link requires three basic functional elements to organize and manage the flow of information to be interchanged among devices:
  - a device acting as a listener;
  - a device acting as a talker;
  - a device acting as a controller.

  Note — The terms talker and listener have specialized meanings in this standard to better describe the role of devices. These terms are used in order to avoid confusion with other technical terms such as transmitter and receiver.
- In the context of the interface system described by this standard:
  - A device with the capability to listen can be addressed by an

interface message to receive device-dependent messages from another device connected to the interface system.

- A device with the capability to talk can be addressed by an interface message to send device-dependent messages to another device connected to the interface system.
- A device with the capability to control can address other devices to listen or to talk. In addition, this device can send interface messages to command specified actions within other devices. A device with only this capability neither sends nor receives device-dependent messages.

Note – The use of the word controller throughout this standard applies strictly to the management (control) of the interface system and does not imply the broad capabilities typically associated with the word in the data processing context.

- Message paths and bus structure
  - The interface system contains a set of 16 signal lines used to carry all information, interface messages and device-dependent messages, among interconnected devices.
  - Messages may be coded on one signal line or on a set of signal lines as determined by the particular message content and its relationship to the interface system.
  - The bus structure is organized into three sets of signal lines:
    - data bus, eight signal lines;
    - data byte transfer control bus, three signal lines;
    - interface management bus, five signal lines.

1) A set of eight interface signal lines carries all 7-bit interface messages and the device-dependent messages:

a) DATA INPUT OUTPUT 1 (DIO1)

. .
. .
. .

h) DATA INPUT OUTPUT 8 (DIO8).

Message bytes are carried on the DIO signal lines:

- in a bit-parallel byte-serial form;
- asynchronously;
- bidirectionally.

Note – A message may be carried on an individual DIO signal line when required.

2) A set of three interface signal lines is used to effect the transfer of each byte of data on the DIO signal lines from a talker or controller to one or more listeners:

a) DATA VALID (DAV) is used to indicate the condition (availability and validity) of information on the DIO signal lines.

b) NOT READY FOR DATA (NRFD) is used to indicate the condition of readiness of device(s) to accept data.

c) NOT DATA ACCEPTED (NDAC) is used to indicate the condition of acceptance of data by device(s).

The DAV, NRFD, and NDAC signal lines operate in what is called a three-wire (interlocked) handshake process to transfer each data byte across the interface.

3) Five interface signal lines are used to manage an orderly flow of information across the interface:

a) ATTENTION (ATN) is used (by a controller) to specify how data on the DIO signal lines are to be interpreted and which devices must respond to the data.

b) INTERFACE CLEAR (IFC) is used (by a controller) to place the interface system, portions of which are contained in all interconnected devices, in a known quiescent state.

c) SERVICE REQUEST (SRQ) is used (by a device) to indicate the need for attention and to request an interruption of the current sequence of events.

d) REMOTE ENABLE (REN) is used (by a controller) in conjunction with other messages, to select between two alternate sources of device programming data.

e) END OR IDENTIFY (EOI) is used (by a talker) to indicate the end of a multiple byte transfer sequence or in conjunction with ATN (by a controller), to execute a parallel poll.

- Interface system elements

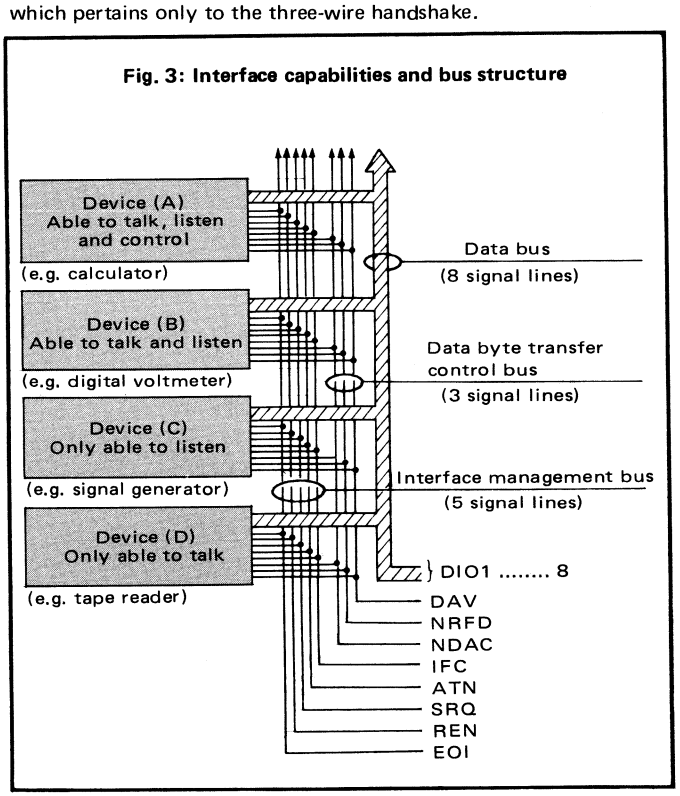
The primary elements of this interface system are:

- functional elements;
- electrical elements;
- mechanical elements.

General Information on Licensing

The interface specified by this standard includes patented matter which pertains only to the three-wire handshake.

Fig. 3: Interface capabilities and bus structure



Other Interface Systems

Besides the GP-IB described above, another system is also widely accepted throughout the world. That system is known as CAMAC (Computer Automated Measurement and Control). It is an international standard established mainly by researchers and scientists engaged in nuclear engineering. CAMAC provides detailed standards for such physical aspects as crate and module design as well as interface standards for signal lines.

For microcomputers, there is the S-100 bus, which has the standardized interior bus system of the microcomputer.

PRODUCTS SELECTION GUIDE

1 Test Signal Sources

Product Name	Type Number	Frequency Range	Output Level & Impedance	Description	See Page
Frequency Synthesizers	AJ-2600	10Hz – 2MHz	-59 – +15dBm, 75Ω (optional 150Ω, 600Ω)	Synchronous operation with the AD-2430/ 2530/2630 selective level meters	16
	AJ-2700	2kHz – 30MHz		Synchronous operation with the AD-2730 selective level meter	18
	AJ-2730	10Hz – 29.99MHz	-50 – +15dBm; 75, 150, 600Ω	Can form a 30MHz comprehensive transmission measuring set when used together with the AD-4730 level meter and the AL-5730 switching unit	20
	AJ-2731	10Hz – 30MHz	-59.9 – +15dBm; 75, 150, 600Ω	Synchronous operation with the AD-2530/ 2630/2730 selective level meters.	22
	AJ-2750B	1mHz – 30MHz	-80 – +15dBm; 75, 150, 600Ω	High resolution, sweep capabilities of frequency and level	24
	GES-100	1 – 30MHz	-60 – +10dBm, 75Ω	Synchronous operation with the SLM-51 selective level meter	26
Oscillators	TC0–47	10Hz – 2MHz	-50 – +20dBm; 75, 600Ω	Decade, low distortion	27
	TC0–48			Continuously adjustable, low distortion	
	GET-36	1 – 250 MHz	-60 – +10dBm, 50 or 75Ω	Synchronous operation with the SLM-51 selective level meter	29
	GET-42SP	1 – 1000MHz	-60 – +5dBm, 75Ω	Synchronous operation with the SLM-42SP selective level meter	
Signal Generators	GE-20C	25kHz – 110MHz	-10 – +123dBμ/-123 – +10dBm, 50Ω	AM Signal generator	30
	GE-502	455kHz – 129.999MHz	-20 – +129dBμ, 50Ω	Synthesized signal generator suitable for modulation characteristics measurements of FM and AM receiving equipment	32
	GE-503	1 – 520MHz	-20 – +123dBμ (-133 – +10dBm), 50Ω	Synthesized signal generator	34
White Noise Generators	GRN-3B	30Hz – 20kHz	-15 – +15dBm, 600Ω		36
	GRN-2	15kHz – 10MHz	-60 – -10dB, 75Ω		

2 Level/Selective Level Meters & Standard Level Calibration Set

Product Name	Type Number	Frequency Range	Output Level & Impedance	Description	See Page
Level Meters	TLM-36B	10Hz – 20kHz	-60 – +30dBm, 600Ω and high	The AD-4730 can form a 30MHz comprehensive transmission measuring set when used together with the AJ-2730 frequency synthesizer and the AL-5730 switching unit	44
	TLM-35B	200Hz – 2 MHz	-60 – +30dBm; 75, 600Ω and high		
	AD-4730	10Hz – 30MHz	-70 – +22dBm; 75, 150, 600Ω and high		42
Selective Level Meters	AD-2430	20Hz – 20kHz	-115 – +32dBm, 600Ω and high	Synchronous operation with the AJ-7000 series synchronous generators (options) and other AJ-series frequency synthesizers	45
	AD-2530	200Hz – 200kHz	-115 – +32dBm; 75, 150, 600Ω and high		
	AD-2630	800Hz – 2MHz	-115 – +32dBm; 75, 150, 600Ω and high		
	AD-2730	10kHz – 30MHz	-115 – +32dBm; 70, 150Ω and high		
	SLM-51	1 – 130MHz	-105 – +21dBm, 75Ω	Synchronous operation with the GES-100 frequency synthesizer	50

Product Name	Type Number	Frequency Range	Output Level & Impedance	Description	See Page
Selective Level Meters	SLM-36	1 – 250MHz	-90 – +21dBm, 50 or 75Ω	Synchronous operation with the GET-36 and GET-42SP oscillators; highly accurate selected frequencies (crystal locked system)	51
	SLM-42SP	1 – 1000MHz	-90 – +21dBm, 75Ω		
	AD-2750B	200Hz – 30MHz	-120 – +30dBm; 75, 135, 150, 600Ω and high	Synchronous operation with the AJ-2750B frequency synthesizer; 8-digit frequency readout	48
	AD-2700	200Hz – 30MHz	-115 – +13dBm; 75 150, 600Ω and high	7-digit frequency readout	47
Standard Level Calibration Set	AD-4030	DC, 20Hz – 1GHz	-1 – +10/11dBm; 75, 110, 150 and 600Ω	Plug-in versatility	52

3 Spectrum Analyzers

Product Name	Type Number	Frequency Range	Output Level & Impedance	Description	See Page
Spectrum Analyzers	AC-8203A	10kHz – 500MHz	-110 – +20dBm; 50, 75Ω	Tracking generator option	56
	AC-8211	100kHz – 1.7GHz	-107 – +20dBm, 50Ω	Digital display of reference level	58

4 Frequency Counters

Product Name	Type Number	Frequency Range	Description	See Page
Frequency Counters	AB-2103	10Hz – 500MHz	Highly stable, 9-digit display	60
	AB-2104	10Hz – 1GHz		

5 Auxiliary Measuring Sets

Product Name	Type Number	Frequency Range	Gain	Impedance		Description	See Page
				Input	Output		
Amplifiers	TA-2A	1kHz	0–60dB	600Ω	600Ω		62
	TA-18	30Hz – 10kHz	15–60dB	600Ω & high	600Ω		
	TA-15B	3–150kHz		75,600Ω & high	75, 600Ω		
	TA-21	10kHz – 50MHz	0–30dB	75Ω	75Ω		
Detector-amplifiers	ED-9	200Hz – 150kHz	80dB	600Ω	600Ω		63
	ED-7	200Hz – 1.2MHz	95dB	75, 600Ω	High		

			Impedance	Attenuation		
Attenuators	AL-205	DC – 150kHz	600Ω	0 – 121dB	Used as testing standards Used for output level adjustments of test signal sources Used for input level adjustments	64
	AL-255		150, 300, 600Ω			
	AL-352	DC – 700kHz	75, 150, 300, 600Ω	0 – 91dB		
	AL-401	DC – 50MHz	75Ω	0 – 91dB		65
	AL-501B	DC – 250MHz		0 – 81dB		
	AL-502B		50Ω			
	AL-511SP		75Ω	0 – 91dB		
	AL-512N		50Ω			
	AL-604B	DC – 1GHz		0 – 61dB		
	AL-611SP		75Ω	0 – 81dB		
Programmable Attenuators	AL-4550	DC – 200kHz	600Ω	0 – 127dB	GP-IB or BCD remote control capability for a complete system use	66
	AL-4551	DC – 500kHz	600Ω			
	AL-4750	DC – 30MHz	75Ω	0 – 95dB		

Variable High Pass Filters (6 models, see pages 68 and 69), Variable Low Pass Filters (5 models, see pages 69 and 70), Switching Units (4 models, see page 71), Programmable Switching Units (3 models, see page 72), Channel Selectors (4 models, see page 73).

6 Impedance/Return Loss Measuring Sets

Product Name	Type Number	Frequency Range	Measurement Range	Companion Instruments Available	See Page
Direct Reading Impedance Bridges	DRZ-1	200Hz – 5kHz	Z: 10 – 10000Ω; $< \phi$: 0 – ±90°	TC0-48 oscillator, ED-9 detector-amplifier	76
	DRZ-2M	200Hz – 100kHz			
	DRZ-3	3 – 150kHz			
	DRZ-4	10 – 500kHz	Z:10 –1000Ω; $< \phi$: 0 – ±90°		
Return Loss Measuring Sets	UM-11B	30Hz – 150kHz	0 – 60dB (line impedance, 100 – 1000Ω)	TC0-48 oscillator, high input impedance detector	77
	UM-14	50kHz – 17MHz	0 – 51dB (line impedance, 37.5 – 150Ω)	AJ-2730 frequency synthesizer AD-4730 level meter	
	UM-18SP	1MHz – 1GHz	0 – 40dB (line impedance, 75Ω)	GET-42SP oscillator	

7 L, C, R Components

Product Name	See Page
Inductors Standard Self Inductors, 5 models available Standard Variable Inductors, 5 models available inductance), 8 models available Decade Inductor (self inductance), Type AM-3301	78

Product Name	See Page
Decade Capacitor, Type DSC-1	78
Decade Resistors, 5 models available	
Slide Rheostats Single Core Slide Rheostats, 45 models available Double Core Slide Rheostats, 46 models available	79

8 Measuring Sets for Components & Telecommunications Cables

Product Name	See Page
L, C & R Measuring Sets	
Inductance Measuring Set	81
Resistance Measuring Sets	
Ohm Meter	82
Wheatstone Bridge	
Insulation Resistance Measuring Sets (2 models available)	83
Highmegohm Meter	84
LCR Measuring Sets	
LCR Meter (digital)	86
Universal Bridges (3 models available)	88–90
LCR Bridge	91

Product Name	See Page
Dielectric Loss Measuring Sets (4 models available)	94–97
Measuring Sets for Telecommunications Cables	
Electrostatic Coupling Measuring Sets	99
Leakance Bridge	100
High Voltage Test Set	101
Line Fault Locators (3 models available)	102–104
Pair Identifier	105
Cable Final Test Set	106
Artificial Telephone Cables (4 models)	108
Transmission Simulator	109

Note: See page 80 for the detailed selection chart of these instruments.

9 Measuring Sets for FDM Communications & Transmission Characteristics

Product Name	Type Number	Frequency Range	Impedance	Description	See Page
Transmission Measuring Sets	TT-3	0.3–3.4kHz	600Ω & high	Can make loop-back test	111
	TT-9	0.2–10kHz	600Ω & high		
	PMS-6C	100Hz – 2MHz	75, 150, 600Ω & high	Housed in a portable carrying case	112
	AH-4730D	10Hz – 29.99MHz	75, 150, 600Ω & high	Composed of the AJ-2730 frequency synthesizer, the AD-4730 level meter and the AL-5730 switching unit	114

	Configuration					
PMS-15A	Main Unit	Base-band Oscillator	IF Frequency Unit	Shift Oscillator Unit	Designed for routine maintenance and adjustment of a detective relay system transmitter-receiver for radio-communications	116
PMS-15B				———		

	Oscillator Frequency		Weighting (CCITT)			
	Telephone	Program	Telephone	Program		
TT-170	0.2–3.6kHz	0.05–10kHz	P53	P53	CCITT transmission measurements of FDM channel translating equipment	117
TT-171		0.04–15kHz		P53, J16		
TT-172				J16		

	Oscillator Frequency		Pilot Oscillator Frequency				
	Group	Supergroup	Group	Supergroup	Line		
TT-180	60.6 – 107.7kHz & 70.8kHz	312.3 – 551.4kHz & 534.8kHz	84.08kHz	411.92kHz	60 or 308kHz	Transmission measurements for FDM group and supergroup channel translating equipment	117
TT-181			84.08kHz 104.08kHz	411.92kHz 547.92kHz	60, 308kHz		
TT-182			104.08kHz	547.92kHz	60 or 308kHz		

	Frequency Range	Impedance		
VST-261	30Hz – 10kHz	600Ω & high	Trolley-type test equipment The VST-251B, VST-252B, and VST-253B have differences in pilot frequencies.	120
VST-262				
VST-251B	300Hz – 150kHz	75, 600Ω & high		
VST-252B				
VST-253B				
VST-20B	300Hz – 2.1MHz	75, 600Ω & high		121
VST-24	50kHz – 7 MHz	75Ω		
AH-4431	30Hz – 15kHz	600Ω & high	Designed for maintenance and construction of PCM stereo signal broadcasting relay systems	122
Transmission Characteristics Curve Tracers — TV-33	0.2–50kHz	110 & 600Ω	Group delay measuring sets	123
TV-37	60–560kHz	75Ω		
Psophometers — NM-36	30Hz – 31.5kHz	600Ω & high	Noise measurement of telephone and program circuits	125
AD-9430	30Hz – 16kHz			126
Telephone Line Weighting Network — NW-1	50–5000Hz	600Ω		128
Crosstalk Measuring Set — PX-1	1–150kHz	120, 150, 200, 300 & 600Ω	0–150dB measurement range	129

10 PCM Transmission Measuring Sets

Product Name	Type Number	Description	See Page
PCM Line Test Set	AP-9600	Span line performance tests and repeater pre-installation tests on PCM-30 system	133
PCM-24 Measuring Test Set	AP-9100	Terminal equipment and repeated line tests on PCM-24 system	134
PCM Line Test Set	AP-9603	Span line performance tests and repeater pre-installation tests on PCM-24 or PCM-48 system	136
Bipolar Error Detectors	AP-7601	Detection of bipolar errors contained in bipolar pulse train; performance test of an individual repeater; AP-7601 for PCM-24 system, EBT-5E for PCM-30 system	137
	EBT-5E		
Pattern Generator	AP-4870	150M bit PCM measuring sets	138
Code Error Detector	AP-7870		
PCM Channel Test Set	AP-9601	PCM multiplex terminal equipment maintenance tests (CCITT G712)	139
Transmission Measuring Sets	AP-9701	Short-distance transmission path measuring set	140
	PMS-11		

11 Data Transmission Measuring Sets

Product Name	Type Number	Data Signalling Rate	Description	See Page
Code Generator	PW-105B	50—200 bits/s	Start-stop system (5-unit code); distortion setting capability	145
Start-stop Distortion Measuring Set	TGK-13F	50—200 bits/s	Total and element distortion measurements	146
Impulsive Noise/Level Hit Measuring Set	ASA-23	0.3—3.4 kHz	Digital display of hit and peak noise (CCITT V.55)	147
Modem Tester	TSD-502A	50—9600 bits/s	Versatile, portable modem tester	148
Telegraph Test Set	AE-1501	50—200 bits/s	General-purpose, multi-function tester	151
Data Communication Analyzer	AE-5102	50—9600 bits/s	Troubleshooting analyzer for data communications network system; on-line monitoring and simulation capability	153

12 Telephone & Exchange Measuring sets

Product Name	Type Number	Frequency Range	Description	See Page
Impulse Sender	TSD-31	1—39 PPS	Performance tests on telephone sets, telephone exchanges, and telephone circuits	155
Sensitivity Measuring Set	T-60NB	1 kHz	Sensitivity and dynamic resistance measurements on T-60, T-60L, T-62 and T-62L telephone transmitters	156
	R-60NB	1 kHz	Sensitivity and impedance measurements on R-60, R-60L, R-62, and R-62L telephone receivers	
Side-tone Attenuation Measuring Set	N-60NB	1 kHz	Side-tone attenuation measurement on N-60, N-60L N-62, N-63 and N-63L telephone networks	

13 Stereohonic FM Broadcast Measuring Sets, FM Linear Detectors & UHF Power Meters

Product Name	Type Number	Frequency Range	Description	See Page
VHF Signal Generator	GE-502	455kHz – 130MHz	High frequency accuracy; suitable for modulation characteristics tests of FM/AM receivers	32, 157
Stereo Signal Generator	HSG-508	20Hz – 15kHz	Composite signal	158
Stereo Signal Demodulator	HSD-508	20Hz – 15kHz	Built-in pilot phase calibration circuit	160
FM Linear Detectors	RDA-203	7MHz – 1 GHz	Standard FM modulation meters; the RDA-203 has a residual AM measurement capability	162
	RDA-204			
	RDA-206	7–520MHz		
Composite Measuring System	HSE-502	76–108/10.7MHz	Stereo characteristics measurements on tuners, transmitters and relay transmitters for FM broadcasting	164
Termination Load Power Meters	DPC-10	DC – 500MHz	15W	165
	DPC-11		30W	
	DPC-12		1.5W	
	DPC-14		7.5W	

14 Optical Communications Measuring Sets

Product Name	Type Number	Measurement Range	Use	Description	See Page
Optical Power Meter	AQ-1111	-70 – +10dBm/0.1nW – 10mW (Si) -50 – +5dBm/10nW – 3mW (Ge)	For minute level measurements	Three different display modes selectable: W, dBm and dB.	168
Standard Optical Power Meter	AQ-1112	-20 – +10dBm/10μW – 10mW	Light source output calibration		170
Chopped Light Power Meter	AQ-1113	-80 – 0dBm (0.85μm band) -70 – 0dBm (1.3μm band)	For extremely low level, measurements		172
Optical Power Meters	OPM-120	1nW – 3mW, -50 – +5dBm	For extremely low level measurements	Analog meter indication in W or dBm	174
	OPM-121	10nW – 10mW, -50 – +10dBm	For low level measurements		
	OPM-122	100μW – 10mW, -10 – +10dBm	For power level standard		
	OPM-123	10mW – 1W, +10 – +30dBm	For midium level measurements		
	OPM-124B	100mW – 10W, +20 – +40dBm	For high power level measurements		
Optical Power Testers	AQ-1130	100nW – 3mW, -40 – +5dBm	For power level measurements of fiber	Capable of measuring power level of fiber with adapter	175
	AQ-1170				

		Base Band	Description	See Page
E/O Converters	AQ-1310	100kHz – 110MHz	Base band modulation electro-optical converters.	178
	AQ-1311	1 – 1000MHz		
O/E Converters	AQ-1401	1 – 1000MHz	Base band modulation optical-electro converters	179
	AQ-1411	1 – 1000MHz		

		Wavelength	Output Level	Description	See Page
Light Sources	AQ-1304	0.85μm (LED)	Approx. -30dBm or more	Modulation: Intensity modulation (IM) with external voice band signal	180
	AQ-1305	1.3μm (LD)	Approx. -10dBm or more		

		Description	See Page
Optical Loss Characteristics Measuring System	AQ-1011	Wavelength: 0.6–1.0μm (Si sensor), 1.0–1.5μm (Ge sensor); using type AQ-1211 programmable monochromator	182
	AQ-1012	Wavelength: 1.0–1.8μm (Ge sensor); using type AQ-1210 programmable monochromator	

15 Logic Analyzer

Product Name	Type Number	Description	See Page
Logic Analyzer	AE-4201	Data input: 32 channels; storage capacity: 1024 bits/channel; for system debugging and maintenance of microprocessor-based equipment	184

16 Microprocessor System Analyzers

Product Name	Type Number	Processor to be connected	Description	See Page
Microprocessor System Analyzers	AE-4101	8080A	For development, production inspection, and maintenance of hardware and software of various microprocessor-based system. Optional 8k-byte RAM available for debugging ROM area. Each of AE-4101C/4103C/4105C/4106C has a built-in cassette MT.	187
	AE-4101C			
	AE-4103	Z80-CPU		
	AE-4103C			
	AE-4105	8085A		
	AE-4105C			
	AE-4106	8086		
	AE-4106C			

17 IC Test Systems

Product Name	Type Number	Use			Description	See Page
		R&D	Production	Acceptance Inspection		
LSI Test Systems	DIC-8030	●	●	●	Functional test system. Hierarchal/distributed system. 10MHz/20MHz. 128 pins maximum.	194
	DIC-8032	●	●	●	Functional test system. Hierarchal/distributed system. 5MHz/10MHz/20MHz. 128 pins maximum.	196
SSI/MSI Test System	DIC-8010	●	●	●	Functional test system. Hierarchal/distributed system. 500kHz. 32 pins maximum.	198
Memory IC Test System	DIC-8020	●	●	●	Hierarchal/distributed system. 20MHz maximum	200
Automatic IC Test System	UIC-5030	●	●	●	DC parameter test system. Micro-CPU controlled system. 0.1mV to 120V, 1nA to 500mA	202
IC Test System	DIC-3040		○	●	Functional test system. Micro-CPU controlled system. 24 pins maximum. Desk-top type	204
IC Testers	AIC-10	●		●	Compact IC tester. Manual testing of AC and DC parameters of op-amp and comparator ICs.	206
	DIC-10	●		●	Compact IC tester for bipolar digital ICs.	207

● ideal ○ applicable

18 Desktop Computer

Product Name	Type Number	Description	See Page
Desktop Computer	AE-8101	Ideal for computation and control/measurement applications, and technical/science applications.	208

19 Analog Computer

Product Name	Type Number	Description	See Page
Analog Computer	ADAC 480	Expandable configulation. One-shot and repetitive operation.	211

20 Training Sets for Educational Use

Product Name	Type Name	See Page
Analog Computer	ADAC L-100	214
Model Computer	AV-7101	216
Transistor Circuit Trainer	TA-13	218
Modulation/Demodulation Circuit Trainer	MD-2	220
Pulse Circuit Trainer	PUO-35	222
A-D/D-A Converter Circuit Trainers	AD-51/DA-51	224
Digital Circuit Trainers	DL-3A/3D	226
Power Supply Circuit Trainer	RTS-19	228
Sequential Controller	SQ-10	230
Automatic Control Technique Trainer	MO-2	232
Thyristor Trainers	SCR-11—15	234
Magnetic Circuit Trainer	MA-6	236
Acoustic Technique Trainer	ASA-13	238
Supersonic Wave Technique Trainer	UST-1	240
Microwave Technique Trainers	Course 1 to 4	242
Filter Circuit Trainers	VF-15/16/17	244

21 Industrial Production & Control Equipment

Product Name	Type Name	See Page
Electronic Micrometers	DEM-200/300/ 600 series	246
Automatic Tool Position Compensating Systems	ALCOS series	248
Digital Scales	DPS-100 series	249
Microscale	DPS-204 (display) DEG-2010A (sensor)	250
Tapeless NC System	ALNUC-12	251
Automatic Positioning Control System	ALNUC-20	252
Automatic Tapping Machine	CPT-3000	253
Copy Drills (NC Boring Machines for PCBs)	CPD-2110/2120/ 4000	254

1 TEST SIGNAL SOURCES

GENERAL INFORMATION

FREQUENCY SYNTHESIZERS

A frequency synthesizer is a test signal source that produces a signal of any desired frequency. The frequency can be obtained by synthesizing a certain unit frequency resulting from dividing or multiplying the frequency of a reference crystal oscillator with high stability and accuracy. In other words, the frequency synthesizer is capable of providing frequencies of the same spectral purity and stability as those of the crystal oscillator in small increments or decrements.

The frequency synthesizer therefore finds application not only in the communications industry but also in all branches of the electronics industry. Further, they have been finding increasing use in many other areas including vibration, resonance (ultrasound) and mechanical engineering where the stability of a high-quality standard is required.

Synthesis Techniques

Three methods of frequency synthesis are available: direct synthesis, indirect synthesis and digital direct synthesis. Each method has its own advantages and disadvantages, as described below.

(1) Direct Synthesis Method

There are three different approaches in the direct synthesis method to accomplish the synthesis of the desired output frequency: the first, by mixing the divided or multiplied reference frequency in a mixer (Fig. 1-a); the second, by mixing frequencies synchronized with the reference frequency (Fig. 1-b); the third, a combination of these two approaches.

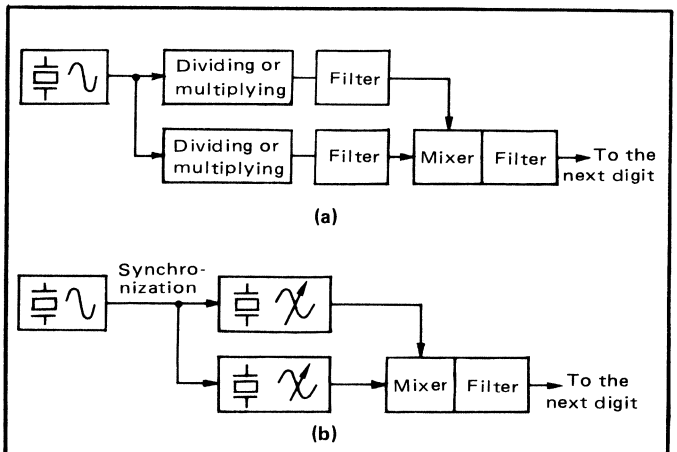


Fig. 1 Direct Frequency Synthesis Method

The direct synthesis method has the advantages of a spectrally pure output signal and fast switching, but also has the disadvantages of difficult suppression of spurious output signals and higher cost.

The direct synthesis method is therefore applied mainly to the applications where fast switching of frequencies (which is to be accomplished in tens of microseconds) is required.

(2) Indirect Synthesis Method

Fig. 2 diagrams the principle of indirect synthesis; the desired output frequency is derived from the VCO (voltage-controlled oscillator) synchronized with the reference crystal oscillator by means of a PLL (phase-locked loop) circuit comprised of VCOs, PDs (phase detectors) and 1/N (frequency dividers). PLL indirect synthesis is accomplished by several methods, but in all methods the stability of synchronized circuits and reduction of FM noise are the chief considerations.

The indirect synthesis method has the advantages of simplified circuit, compact design, limited spurious output signals and multi-digit accommodation in a single loop PLL. On the other hand, it also has the disadvantages of slow switching, possible FM noise generation, and necessity of prevention of asynchronism.

In recent years, however, these problems except for the switching speed have been overcome with the advent of high performance phase detectors realized by advanced IC

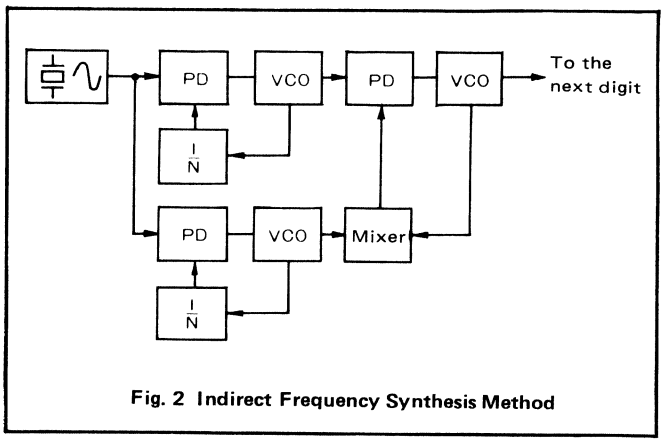


Fig. 2 Indirect Frequency Synthesis Method

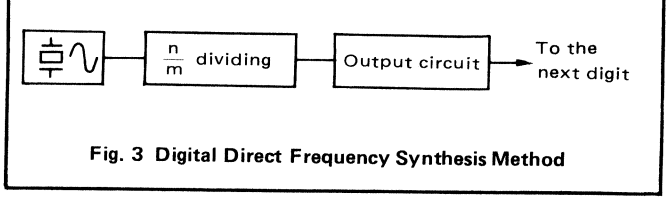


Fig. 3 Digital Direct Frequency Synthesis Method

technology. The indirect synthesis method now provides signals of high spectral purity comparable to those generated by direct synthesis.
Ando's frequency synthesizers employ the PLL system indirect method featuring low FM noise and limited spurious signals.

(3) Digital Direct Synthesis Method

In a frequency synthesizer employing the digital direct synthesis method, the main circuits are composed of logic ICs. The output frequency of the reference crystal oscillator is divided by the use of ROM, cumulative adder and other circuit devices to obtain the desired frequency. In the output circuits, however, analog circuits such as filters, mixers and D-A converters are employed.
The digital direct synthesis method has the advantages of fast switching, ease in control, free phase shift, and compact design and the disadvantages of the upper frequency limit and possible clock noise generation.
The frequency synthesizer employing the digital direct synthesis method has the advantages of easy control and free phase shift, and is suitable for generation of a variety of waveforms.

Ando's Frequency Synthesizers

The frequency synthesizers are required to meet the following requirements.

- High frequency accuracy, stability and resolution
- High spectral purity of the output signal
- Wide-range output level settability and stability
- Suitability for automatic measurement systems

All these requirements were taken into due consideration in the design and manufacture of Ando's frequency synthesizers listed in this catalog. These instruments are very useful for the measurements of the transmission characteristics of communication lines and equipment and for the tests and inspections of various electronic circuits and parts. As high stability and resolution of both the frequency and level are achieved, the characteristics of instruments and components alike can be determined with high accuracy and great ease, no matter how sharp their characteristic curves may be.

- High efficiency of transmission characteristics measurement can be achieved when the frequency synthesizers are operated in conjunction with suitable types of Ando's selective level meters.
- To meet the growing demands to time-saving automatic measurement systems, all models of Ando's frequency synthesizers but AJ-2730 have been provided with remote control capability of the frequency.

In the AJ-2731 not only the frequency but the output level can be controlled externally. This model finds optimum use in the applications where automation is particularly important.
The AJ-2600, AJ-2700 and AJ-2731 are designed to match GP-IB, interface bus which has been developed to achieve worldwide standardization of the control methods. Therefore, Ando's frequency synthesizers have applicability for an automatic measurement system.

OSCILLATORS

Ando's sine wave oscillators are available in various types, covering the frequency range from 5 Hz to 1000 MHz.
These oscillators are divided into two groups by oscillation types: RC Wien bridge (AJ-1101, TCO-47 and TCO-48) and LC types (GET-36 and GET-42SP).
The RC oscillator has a frequency selective network of resistance and capacitance. Q which is a measure of selectivity cannot essentially become larger than 1/2. (It is 1/3 in a Wien bridge.) In a bridge circuit, however, where feedback is applied and linear oscillation is caused to occur, Q can be considered to be a multiple of the applied feedback amounted. This arrangement makes it possible to obtain a low-cost oscillator with low distortion and wide frequency range.
The frequency can be varied if either C or R is variable. In the continuously variable AJ-1101 and TCO-48 oscillators C (capacitor) is variable, while in the decade dial type TCO-47 oscillator R is variable. Frequency ranges are switched by changing resistors in the frequency-determining network in the former, while ranges are switched by changing capacitors in the latter. In either type, a factor of 10 is used as a multiplier of the frequency indication for ease of reading.
The GET-36 and GET-42SP are LC type oscillators. The one of main features of these oscillators is that they have lock-in type oscillator units with two frequency dials. The frequency of oscillation obtained in these oscillators is "$f_1 + f_2$".
Since the f_2 dial as well as the f_1 dial (as in the GET-42P) is phase-locked to the harmonics of the built-in reference crystal oscillator, frequency stability is quite high. As the output frequency is obtained by beat-down, and frequencies 2 to 3 times as high as the output signal are produced inside these LC oscillators, precision constructions are employed.

FREQUENCY SYNTHESIZER

TYPE AJ-2600

- *10Hz to 2MHz*
- *0.1Hz resolution*
- *A wide variety of options*

FEATURES

- Frequencies can be set by six dials manually, and also the external remote control function can be added as an option. Thus, this instrument can be used as a signal source for an automatic measuring system.
- An output impedance of 75Ω/150Ω/600Ω balanced can selectively be added as an option. The standard output impedance is 75Ω unbalanced. These output impedances can be added up to 2 kinds.
- The least significant three digits of frequency dials can be changed continuously. The frequency sweep can also be done by adding an external sweep signal (sawtooth wave 0 to 10V).
- This instrument provides local oscillator signal output for synchronous measurement, and it can measure the transmission characteristics with high efficiency by combining it with ANDO's AD-2630/2530/2430 selective level meter.

TYPE AJ-2600, FREQUENCY SYNTHESIZER

SPECIFICATIONS

Frequency setting modes: 1. Six decade dials
2. Three decade dials and one continuously variable dial

Frequency range	200 Hz to 1.99999 MHz	20 Hz to 199.999 kHz	10 Hz to 19.9999 kHz
Frequency resolution	10 Hz	1 Hz	0.1 Hz
Continuous width	10 kHz	1 kHz	100 Hz
Local oscillator frequency	5 to 7 MHz	500 to 700 kHz	50 to 70 kHz

Reference oscillator frequency accuracy: $\pm 5 \times 10^{-6}$, 5 MHz.
Output level: −59 to +15 dBm in 1 dB steps. Fine control provided.
Output level frequency response: Within 0.3 dB.
Output impedances: 75Ω unbalanced (standard); 75Ω, 150Ω, 600Ω balanced (optional).
Harmonic distortion: 40 dB or more.
Non-harmonic spurious: −60 dB or less.
Frequency sweep: Can be swept by an external sweep signal; continuous width sweep.
Power requirements: 100V AC, 50/60 Hz.
Dimensions: Approx, 150(H) x 425(W) x 350(D)mm.
Weight: Approx. 15 kg.

OPTIONS

Output impedance options

Impedance / Options	75Ω unbal. 10 Hz–2 MHz	75Ω bal. 10–650 kHz	150Ω bal. 10–650 kHz	600Ω bal. 0.3–150 kHz	600Ω bal. 30 Hz–20 kHz
Option No. 01	●	●	●		
Option No. 02	●	●		●	
Option No. 03	●	●			●
Option No. 04	●			●	●

External remote control options

Option No. 11	Ext. remote control is possible for frequency setting	BCD code (frequency, 6 digits; range, 1 digit)
Option No. 12		GP-IB code (bit parallel, byte serial)

FREQUENCY SYNTHESIZER

TYPE AJ-2700

GP-IB

- *2kHz to 30MHz*
- *100Hz resolution*
- *A wide variety of options*

FEATURES

- Frequencies can be set by six dials manually, and also the external remote control function can be added as an option. Thus, this instrument can be used as a signal source for an automatic measuring system.
- An output impedance of 75Ω/150Ω/600Ω balanced can selectively be added as an option. The standard output impedance is 75Ω unbalanced. These output impedances can be added up to 2 kinds.
- The least significant three digits of frequency dials can be changed continuously. The frequency sweep can also be done by adding an external sweep signal (sawtooth wave 0 to 10V).
- This instrument provides local oscillator signal output for synchronous measurement, and it can measure the transmission characteristics with high efficiency by combining it with ANDO's AD-2730 Selective level meter.

TYPE AJ-2700, FREQUENCY SYNTHESIZER

SPECIFICATIONS

Frequency range: 2 kHz to 29.9999 MHz.

Frequency setting modes: 1. Six decade dials
2. Three decade dials and one continuously variable dial.

Frequency resolution: 100 Hz.

Continuous width setting: 100 kHz.

Local oscillator: Frequency: 50 to 80 MHz

Reference oscillator: Frequency: 50 MHz
Accuracy: $\pm 5 \times 10^{-6}$

Output level: −59 to +15 dBm in 1 dB steps. Fine control provided.

Output level frequency response: Within 0.3 dB.

Output impedances: 75Ω unbalanced (standard); 75Ω, 150Ω, 600Ω balanced (optional).

Harmonic distortion: 40 dB or more, 2 kHz to 4 MHz.
30 dB or more, 4 to 30 MHz.

Non-harmonic spurious: −60 dB or less, 2 kHz to 20 MHz.
−55dB or less, 20 to 30 MHz.

Frequency sweep: Can be swept by an external sweep signal; continuous width sweep.

Power requirements: 100V AC, 50/60 Hz.

Dimensions: Approx. 150(H) x 425(W) x 350 (D)mm.

Weight: Approx. 15 kg.

OPTIONS

Output impedance options

Impedance / Options	75Ω unbal. 2 kHz–30 MHz	75Ω bal. 10–650 kHz	150Ω bal. 10–650 kHz	600Ω bal. 0.3–150 kHz
Option No. 01	●	●	●	
Option No. 02	●	●		●

External remote control options

Option No. 11	Ext. remote control is possible for frequency setting	BCD code (frequency, 6 digits; range, 1 digit)
Option No. 12		GP-IB code (bit parallel, byte serial)

FREQUENCY SYNTHESIZER
TYPE AJ-2730

- *Wide frequency range—10 Hz to 30 MHz*
- *Compact design with superior stability and operation*

The AJ-2730 that employs a PLL circuit provides accurate signals over a wide frequency range (10 Hz to 30 MHz) from the voice band to the video band. As it provides low-distortion signals with excellent output amplitude settability (frequency response: ±0.2 dB from 100Hz to 5MHz; ±0.3dB from 10Hz to 20MHz), it serves as an excellent signal source for transmission characteristic measurements. The AJ-2730 also gives excellent performance as a component unit of Type AH-4730D Transmission Measuring Test Set, when operated in conjunction with Ando's Type AD-4730 Level Meter and Type AL-5730 Switching Unit.

FEATURES

- Accurate and stable frequency generation.
- Wide frequency range—10 Hz to 30 MHz. 20 to 30MHz is an extension frequency range. This extension frequency can be obtained from a terminal in the rear panel.
- Small in size, light in weight.

This photo shows the AH-4730D Transmission Measuring Test Set which employs the AJ-2730 Frequency Synthesizer.

TYPE AJ-2730, FREQUENCY SYNTHESIZER

SPECIFICATIONS

Frequency range	10 Hz to 20 MHz	Extension range: 20 to 30 MHz (as for the extension range specifications, see the item "Frequency extension" in this table).		
Frequency setting	Three decade dials and seven in-line band selection switches			
Frequency accuracy	$\pm 5 \times 10^{-5}$ (at 10° to 30°C with line voltage variations of ± 10%)			
Frequency stability	$\pm 3 \times 10^{-6}$/°C (at 0° to 40°C)			
Output level	−50 to +15 dBm in 1 dB steps; fine control provided			
Frequency response (+5 dBm reference)	±0.2 dB, 100 Hz to 5 MHz ±0.3 dB, 10 Hz to 20 MHz			
Output level accuracy	±0.2 dB (100 kHz, +5 dBm reference)			
Output level stability	±0.1 dB including line voltage variations of ±10%			
Attenuator step accuracy	±0.2 dB			
Harmonic distortion (2nd and 3rd)	−30 dB or less, 10 to 100 Hz −40 dB or less, 100 Hz to 5 MHz −35 dB or less, 5 to 10 MHz −30 dB or less, 10 to 20 MHz			
Output impedance and return loss	Impedance	Frequency	Return loss	Connector
	600Ω balanced	0.3 to 150 kHz	−35 dB or less	I-214
	150Ω balanced	10 to 650 kHz	−35 dB or less	I-214
	75Ω balanced	10 to 650 kHz	−35 dB or less	I-214
	75Ω unbalanced	10 Hz to 10 MHz	−35 dB or less	BNC
		10 to 20 MHz	−30 dB or less	
Frequency extension (using a rear panel terminal)	Frequency range: 20 to 30 MHZ Output level −2 dBm ±3 dB, 75Ω unbalanced (BNC connector) Harmonic distortion: −25 dB or less			
Power requirements	100V AC ±10%, 50/60 Hz; approx. 37 VA			
Dimensions	Approx. 100(H) x 350(W) x 250(D) mm			
Weight	Approx. 7.5 kg			
Accessories supplied	One balancing cable (1.5 m long, terminated on both ends with I-214 connectors) One coaxial cable (1.5 m long, terminated on both ends with BNC connectors) One U-link			

FREQUENCY SYNTHESIZER

TYPE AJ-2731

GP-IB

- *Wide frequency range from 10Hz to 30MHz*
- *Remote control capability*
- *Digital display*
- *Multiple impedance selection*

The AJ-2731 is a constant amplitude, low distortion signal source which provides sine wave signals from 10 Hz to 29.99999 MHz. A 50 MHz crystal oscillator is employed as a reference oscillator. The sine wave signals with the same frequency stability and accuracy as the internal crystal oscillator can be obtained.

The AJ-2731 is a useful signal source which finds use in a wide variety of applications such as transmission characteristics measurements of communication lines and equipment, frequency characteristics measurements of electronic components, etc. Remote control capabilities of frequency and output level afford the flexibility for automatic measurement system applications.

FEATURES

- Wide frequency range from 10 Hz to 29.99999 MHz.
- Frequencies are selected by seven-digit decade dials in 0.1 Hz fine steps, and output levels are selected by three-digit decade dials in 0.1 dB fine steps.
- Frequencies and output levels can be remotely controlled.
- Frequencies and output levels can be digitally displayed.
- Frequency sweep can be made by applying a sweep signal externally.
- As a local oscillator for synchronous measurements is incorporated in this instrument, it is capable of efficient measurements of transmission characteristics when combined with Ando's AD-2000 series selective level meters.

TYPE AJ-2731, FREQUENCY SYNTHESIZER

SPECIFICATIONS

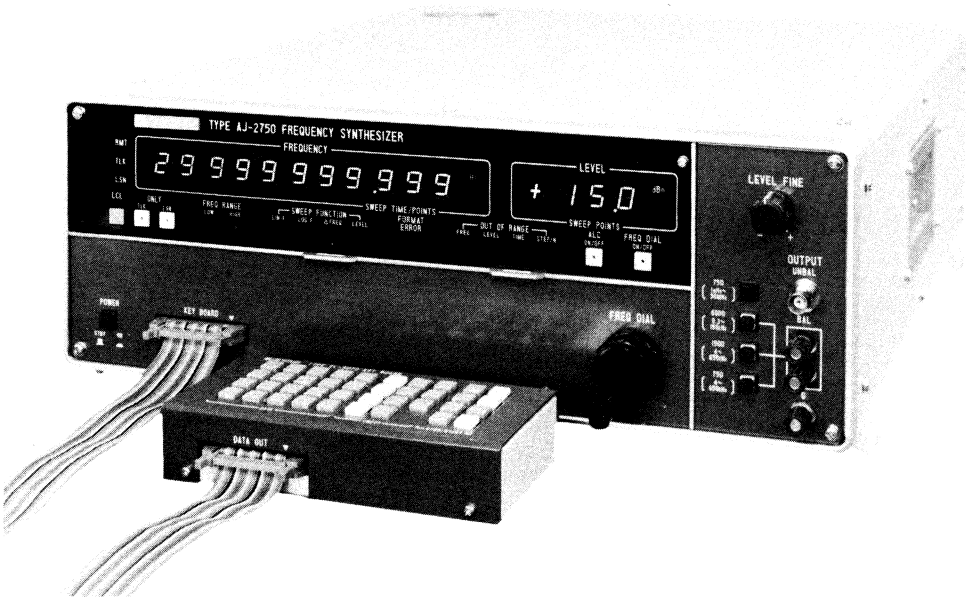
Frequency range		1kHz to 30MHz	100Hz to 3MHz	10Hz to 300kHz
Frequency setting		Seven decade dials (2999999 max.) and one continuously adjustable dial		
Frequency resolution		10Hz	1Hz	0.1Hz
Continuous width		30MHz, 100kHz	3MHz, 10kHz	300kHz, 1kHz
Local oscillator output frequency		50 to 80MHz	5 to 8MHz	500 to 800kHz
Internal reference frequency accuracy		50MHz ± 5×10^{-6} (5 to 35°C). 50MHz ± 5×10^{-7} (5 to 35°C) optional.		
Output level	Range	-59.9 to +15dBm in 0.1dB steps (three dials)		
	Accuracy	±0.2dB (+5dBm, 100kHz)		
	Frequency response	±0.2dB (+5dBm, 1kHz to 10MHz) ±0.3dB (+5dBm, 10Hz to 30MHz)		
Attenuator step accuracy		±0.2dB (10Hz to 10MHz) ±0.3dB (10 to 30MHz)		
Output impedance and return loss		Impedance	Frequency	Return loss
		75Ω unbalanced	10Hz to 30MHz	30dB or more (10Hz to 20MHz) 25dB or more (20 to 30MHz)
		75Ω balanced	10 to 650kHz	35dB or more
		600Ω balanced	300Hz to 150kHz	35dB or more
		150Ω balanced	10 to 650kHz	35dB or more
Higher harmonic distortion		40dB or more (1kHz to 4MHz, 2nd and 3rd harmonics) 35dB or more (10Hz to 30MHz, 2nd and 3rd harmonics)		
Spurious		Spurious \ Range	1/1	1/10	1/100
		-60dB or less	1kHz to 20MHz	100kHz to 2MHz	10Hz to 200kHz
		-55dB or less	20 to 30MHz	2 to 3MHz	200 to 300kHz
Frequency sweep		By an external sweep signal. Capable of sweeping continuous width.		
External control		Both frequency and output level can be controlled by the GP-IB.		
Power requirements		100V AC, 50/60Hz; approx. 135VA		
Dimensions		Approx. 200 (H) x 425 (W) x 350 (D) mm		
Weight		Approx. 25kg		
Accessories supplied		One cable terminated on both ends with I-214 connectors (1m long) One cable terminated on both ends with BNC connectors (1m long)		

FREQUENCY SYNTHESIZER

TYPE AJ-2750B

GP-IB

- *11-digit frequency resolution in 1μHz steps*
- *Delivers a high degree of spectral purity; spurious output levels below-70 dB*
- *Built-in microprocessor provides digital sweeps of frequency and output level*
- *The removable control section makes the frequency synthesizer easy to use*



Type AJ-2750 Frequency Synthesizer features 11-digit frequency resolution and output signals of high spectral purity. The built-in microprocessor provides sweeps of frequency and output level. The AJ-2750 is an ideal signal source for time-saving measurements and complete system use.

USES

- Measurement of characteristics of filters of large attenuation
- Measurement of frequency responses of FDM systems over the frequency range of from voice band to coaxial carrier band
- High-accuracy measurements over an ultra-low frequency range

FEATURES

- Frequency range of 0.001 Hz to 29.999999999 MHz and 1 μHz resolution below 30 kHz.
- Signals of high spectral purity permit accurate measurement of filters of large attenuation.
- The built-in microprocessor provides digital sweeps of frequency (linear, log) and arbitrary setting of step frequency and sweep time.
- Digital sweep of output level and arbitrary setting of step level, number of steps and sweep time are possible.
- The built-in GP-IB facilitates easy system use.

TYPE AJ-2750B, FREQUENCY SYNTHESIZER

SPECIFICATIONS

Frequency	Range		100 Hz to 29.999999999 MHz, 1 mHz resolution			
			0.001 Hz to 29.999999999 kHz, 1 μHz resolution			
	Setting		11 digits (through a keyboard or frequency setting dials)			
	Reference oscillator	Frequency	5 MHz			
		Stability	Units / Item	Standard unit	Optional units 01	Optional units 02	Optional units 03
			Long term	2×10^{-8} /day or less	5×10^{-9} /day or less	2×10^{-9} /day or less	5×10^{-10} /day or less
			Temperature (25°C±25°C)	Within $\pm 5 \times 10^{-8}$	Within $\pm 2 \times 10^{-8}$	Within $\pm 1 \times 10^{-8}$	Within $\pm 5 \times 10^{-9}$
Signal purity	Harmonic distortion attenuation		40 dB or more from 1 kHz to 10 MHz for both the 2nd and 3rd harmonics 30 dB or more from 10 Hz to 30 MHz for both the 2nd and 3rd harmonics			
	Non-harmonically related spurious signals		-70 dB or less			
	Phase noise		-75 dB or less (in a 17 kHz band centered on the carrier), 0 dB = 100 kHz DEVN			
Output level	Range		-80 to +15 dBm in 0.1 dB steps (with fine adjustment dial)			
	Frequency response		Within ±0.2 dB from 1 kHz to 10 MHz at +5 dBm output Within ±0.3 dB from 10 Hz to 30 MHz at +5 dBm output			
	Accuracy		Within ±0.2 dB at 100 kHz and +5 dBm output			
	Attenuator step accuracy		Attenuation (dB) / Frequency	10 Hz to 10 MHz	10 MHz to 30 MHz	
			-30 to +15	Within ±0.2 dB		
			-40 to -30	Within ±0.2 dB		
			-60 to -40	Within ±0.2 dB	Within ±0.3 dB	
			-80 to -60	Within ±0.4 dB	Within ±0.6 dB	
	Output level impedance		Impedance	Frequency range	Return loss	Connector
			75 Ω unbalanced	0.001 Hz to 20 MHz	30 dB or more	BNC
				20 MHz to 30 MHz	25 dB or more	
			150 Ω balanced	4 kHz to 650 kHz	30 dB or more	I-214
			600 Ω balanced	300 Hz to 150 kHz		
			75 Ω balanced	4 kHz to 650 kHz		
	Setting		Through keyboard (switch — selection of impedances)			
Sweep capability	Digital sweep of frequency		(1) Linear and exponential sweep capability. (2) Sweep step frequency, number of steps and sweep time per step can be set arbitrarily. (3) Normal and single sweep capabilities.			
	Digital sweep of output level		(1) Sweep step level, number of steps and sweep time per step can be set arbitrarily. (2) Normal and single sweep capabilities.			
Data memory			The data on the frequency and output level set manually can be stored in memory and retrieved.			
Function memory			A set of parameters of each sweep function can be stored in memory and retrieved.			
External control			Both frequency and output level can be controlled by the GP-IB .			
Displays			Frequency: Decimal 11-digit display Output level: Decimal 3-digit display with polarity Other displays: Error, sweep time, number of steps, remote control			
Auxiliary outputs			5 MHz reference frequency input/output and sweep signal output			
Power requirements			100 V AC, 50/ Hz			
Dimensions and weight			Approx. 150 (H) x 425 (W) x 450 (D) mm, approx. 27 kg			

Note. Unbalanced 50Ω (instead of unbalanced 75Ω) output impedance (BNC connectors) may be offered as an option.

COMPANION INSTRUMENTS FOR SYSTEM USE

Name of Instrument	Type Number
Desktop computer	AE-8101 (amics 80 series)
Level meter	AD-2750B
Attenuators	AL-4550/4551/4750
Switching units	AL-5530/5630/5731
Channel selectors	AL-5570/5571/5770/5771

FREQUENCY SYNTHESIZER

TYPE GES-100

- *1 to 130 MHz*
- *1 kHz resolution*

The GES-100 Frequency Synthesizer is a high performance oscillator generating sine wave signals with 1 kHz resolution over the frequency range of 1 to 130 MHz. Because a crystal oscillator is employed as a reference oscillator, highly accurate and stable frequencies can be obtained.
The GES-100 has a wide range of applications and particularly useful for precision measurements on crystal filters and transmission circuits. It can form a transmission measurement combination when operated in conjunction with Ando's SLM-51 selective level meter. The combination features time-saving measurements owing to synchronous operation.

FEATURES

- BCD remote control capability of frequency
- Frequency sweeping capability (with an external sweep signal)
- Digital display of frequency (5½-digit)
- Synchronous operation with Ando's selective level meter, Type SLM-51

SPECIFICATIONS

Frequency range:	1 to 130 MHz.
Frequency setting:	Five decade dials and one continuously variable dial. Manual and remote modes.
Frequency resolution:	1 kHz.
Continuous width setting:	130 MHz, 100 kHz, 1 kHz.
Reference oscillator:	5 MHz, 1 x 10^{-7}/day stability.
Output level:	–60 to +10 dBm in 1 dB steps, fine control provided.
Frequency response (10 MHz, +5 dBm ref.):	±0.2 dB, 1 to 70 MHz. ±0.3 dB, 70 to 130 MHz.
Harmonic distortion (+10 dBm reference):	(For both 2nd and 3rd harmonics) 40 dB or more, 1 to 70 MHz. 30 dB or more, 70 to 130 MHz.
Output impedance:	75Ω unbalanced.
Spurious:	–60 dB or less.
Remote control signal:	BCD code. Low level, 0 to 0.8V. High level, +3.5 to +5V.
Frequency sweep range:	1 kHz to 130 MHz by an external sweep signal.
Power requirements:	100V AC, 50/60 Hz; approx. 87VA.
Dimensions:	Approx. 250(H) x 450(W) x 300(D) mm.
Weight:	Approx. 21 kg.
Accessories supplied:	One coaxial cable terminated on both ends with SP-3CP connectors (1 m long).

OSCILLATORS
TYPES TCO-47/48

- *Wide frequency range—10 Hz to 2 MHz*
  TCO-47: Decade type
  TCO-48: Continuously adjustable type
- *Low distortion*

TCO-47

TCO-48

Low-distortion oscillators Types TCO-47 and TCO-48 provide high quality signals for transmission line measurements from 10Hz to 2 MHz. The TCO-47 and TCO-48 differ from each other in frequency selection.

TCO-47: Any frequency between 10 Hz and 2 MHz can be selected to three significant figures by three decade dials and one frequency multiplier dial. (Furthermore, the continuously adjustable dial of 0 to 0.01 Hz provides more discrete frequency settings). The TCO-47 features higher frequency accuracy and stability as compared with the TCO-48. This model affords great ease of operation, for the desi,ed frequency can be set with reference to the most significant figure on the decade dial.

TCO-48: This oscillator generates signals in the frequency range of 10 Hz to 2 MHz divided into six bands, and the frequency of each band can be continuously varied by one dial. The TCO-48 serves a better purpose than the TCO-47 in the signal where the frequency must be quickly changed from one level to the other or the frequency of one band must be minutely varied.

FEATURES

- Low-distortion signals
  Average distortion: 0.03% or less (70 dB or more); 10 kHz to 90 kHz, + 10 dBm into 75Ω load
- High frequency accuracy
  ±(0.3% + 1 Hz), 10 Hz to 50 kHz for the decade dial type (TYPE TCO-47)
- Easy frequency setting
- Signals of high output level (+20 dBm)
- Monitor meter of output level
- Output impedances of 600 Ω and 75 Ω are provided for all bands

MATCHING LEVEL METERS

The following level meters which can be used with the TCO-47 and TCO-48 are also available from Ando.

- TYPE TLM-36B LEVEL METER (10 Hz to 20 kHz)
- TYPE TLM-35B LEVEL METER (200 Hz to 2 MHz)

TYPES TCO-47/48, OSCILLATORS

SPECIFICATIONS

Type	TCO-47	TCO-48
Frequency range	10Hz to 2MHz	
Frequency setting	6 bands, decade Decade dials: 1Hz X 10, 0.1Hz X 10, 0.01Hz x 10 Continuously adjustable dial: 0 to 0.01Hz Multiplier dial: X10, X100, X1k, X10k, X100k, X100k + 1MHz	6 bands, continuously adjustable Continuously adjustable dial: 1 to 10 Hz Multiplier dial: X10, X100, X1k, X10k, X100k, X100k +1 MHz
Frequency accuracy	± (0.3% + 1Hz), 10Hz to 50kHz ±0.5%, 50kHz to 100kHz ±0.7%, 100kHz to 2MHz	± (3% + 2Hz), 10Hz to 100Hz ± (3% + 1Hz), 100Hz to 100kHz ± 5%, 100kHz to 2MHz
Output impedance	600Ω balanced (connector: I-214) 75Ω unbalanced (connector: BNC)	
Output level	−50 to + 20 dBm (Output attenuator: 10 dB X 5; with 10 dB level adjusting knob) (Output meter: 0 to ±10 dBm)	
Output/frequency characteristics	±1 dB at +10 dBm output (dial setting +10 dBm and meter reading 0 dBm)	2 dB or less
Output meter scale error	±1 dB at meter scale 0 dBm	
Distortion	At +10 dBm output for 75Ω impedance (dial setting +10 dBm and meter reading 0 dBm) 50 dB or more, 10Hz to 1MHz 65 dB or more, 100Hz, to 90kHz 70 dB or more, 10 to 90kHz 45 dB or more, 1 to 2MHz	
Power requirements	100V AC, 50/60Hz	100V AC, 50/60Hz
Dimensions	Approx. 150(H) X 280(W) X 200(D) mm	Approx. 200(H) X 150(W) X 200(D) mm
Weight	Approx. 5.5 kg	Approx. 5 kg

OSCILLATORS
TYPES GET-36SP/36N/42SP

● *1 to 250MHz/1000MHz Precision VHF Oscillators*

Type GET-36 and Type GET-42SP Oscillators, being provided with the frequency crystal-locking system and synchronous tuning capabilities, allow the user to make accurate, rapid test. They deliver a broad range of output level, covering a high frequency range. The output frequency can be easily set on film scale without band changing. Also, AGC circuits maintain constant, stable frequency characteristics. Due to their precision, these oscillators are well suited for measuring high precision electrical components such as crystal filters now coming into common use, in addition to measuring on transmission lines, equipment and cables.
The GET-42SP provides both the coarse and fine frequency selections in phase-locked steps of 10MHz (coarse) and 100 kHz (fine), producing results of extraordinarily high frequency accuracy, comparable to that of a synthesizer.

TYPE GET-42SP

SPECIFICATIONS

Type	GET-36SP/GET-36N	GET-42SP
Frequency range	1 to 250 MHz, continuously adjustable (two internal local oscillators provided: f_1, coarse; f_2, fine)	1 to 1000 MHz, continuously adjustable (two internal local oscillators provided: f_1, coarse; f_2, fine)
Frequency accuracy/stability	± (2×10^{-5} + 20 kHz) (f_1, locked in 5 MHz spectrum steps; f_2, continuous)	± 5×10^{-7}/day (f_1, locked in 10 MHz spectrum steps; f_2, locked in 100 kHz spectrum steps) ± (2×10^{-6} + 20 kHz) (f_1, locked in 10 MHz spectrum steps; f_2, continuous)
Output level	−60 to +10 dBm in 1 dB steps	−60 to +5 dBm in 1 dB steps
Output impedance	GET-36SP: 75Ω unbalanced Connector: SP female GET-36N: 50Ω unbalanced Connector: N female	75Ω unbalanced Connector: SP female
Frequency response	±0.3 dB	±0.3 dB, 1 to 600 MHz ±0.5 dB, 1 to 1000 MHz
Harmonic distortion (for both 2nd and 3rd harmonics)	30 dB or more	30 dB or more, 1 to 600 MHz 25 dB or more, 600 to 1000 MHz
Synchronous operation	Possible (when combined with the SLM-36 Selective Level Meter)	Possible (when combined with the SLM-42SP Selective Level Meter)
Power requirements	100V AC, 50/60 Hz; approx. 67 VA	100V AC, 50/60 Hz; approx. 65 VA
Dimensions and weight (approx.)	300(H) x 425(W) x 300(D) mm; 26 kg	300(H) x 425(W) x 300(D) mm; 31 kg

AM SIGNAL GENERATOR
TYPE GE-20C

- *Wide frequency range—25 kHz to 110 MHz in eight bands*
- *Digital readout of frequency—4½-digit LEDs*

The GE-20C is a standard AM signal generator featuring a wide frequency range from 25kHz to 110MHz, a wide output level range from -123 to +10dBm, low distortion and low spurious. These features make the instrument ideal for communication equipment testings.

FEATURES

- As the GE-20C single-handedly covers a wide frequency range from 25kHz to 110MHz, it saves the trouble of using different signal generators required for such wide frequency applications in general.
- The GE-20C has an automatic level control circuit so that once a level is set, it does not need any further adjustment even when a band is changed.
- As MW and FM bands are included in one band each, adjustments in trackings and other operations are easy.
- Frequencies are easily set using the 4½ LED display.
- Effective RF shielding (little leakage radiation) and output range permit receiver sensitivity measurements to be made down to power levels of 1μV.
- Built-in 400Hz/1kHz modulation signal generator.

TYPE GE-20C, AM SIGNAL GENERATOR

SPECIFICATIONS

Frequency range:	25 kHz to 110 MHz in 8 bands. A: 25 – 65 kHz B: 65 – 180 kHz C: 180 – 500 kHz D: 500 – 1700 kHz (BC band) E: 1.6 – 5 MHz F: 5 – 16 MHz G: 16 – 50 MHz H: 50 – 110 MHz (FM band)
Frequency display:	4½-digit LED display. ±1 count accuracy.
Output level:	–10 to +123 dBμ (0.3 μV to 1.4V) or –123 to +10 dBm in 10 dB steps. 10 dB fine control provided.
Output impedance:	50Ω unbalanced.
Output level accuracy:	±1 dB (for meter readings 0 dBm). Output level indicated meter accuracy is ±3% of full scale (current value).
Spurious:	–20 dB or less.
Internal modulation frequency:	400 Hz, 1kHz; ±10%.
External modulation frequency:	50 Hz to 15 kHz on all bands except bands A, B, C.
Modulation depth:	AM 0 to 85%.
Modulation accuracy:	±10% of full scale on all bands except band H.
Modulation distortion:	5% or less (at 30% modulation and less than 10 dBm output).
External modulation input impedance:	600Ω unbalanced.
Power requirements:	100V AC ±10%, 50/60 Hz. Approx. 70 VA.
Dimensions:	Approx. 150H x 425W x 300D mm.
Weight:	Approx. 17 kg.
Accessories supplied:	One cable (both ends terminated with BNC connectors, 1 m long).

VHF SIGNAL GENERATOR

TYPE GE-502

- *Frequency range from 455kHz to 129.999MHz*
- *FM/AM modulation capability*
- *Remote control operation of frequencies and output levels*
- *Suitable for both laboratory and production testings of FM/AM receivers*

The GE-502 VHF Signal Generator, a synthesized FM-AM signal generator used to measure the modulation characteristics of FM-AM receivers, covers a frequency range from 455 kHz to 129.999 MHz with output levels from -20 to +129 dBμ.

The GE-502 can provide complete stereo FM signals when used together with ANDO's HSG-508 Stereo Signal Generator, therefore it can be used for adjusting and testing IFs and VHF bands of FM stereo receivers.

FEATURES

1. Excellent frequency stability because a synthesized oscillator circuit is used, and therefore requires no frequency counter.
2. Frequencies are displayed on LEDs (6 digits max.), which facilitates frequency settings.
3. Frequencies can be set in 1 kHz steps, which is sufficient resolution for effective selectivity measurements of receivers.
4. Frequency and output levels can be remotely controlled.
5. Keeps FM distortion and frequency deviation constant despite frequency changes.
6. FM and AM modulation can be accomplished at the same time.
7. The frequency deviation meter employs a peak indicating circuit which minimizes stereophonic and monophonic signal errors.

TYPE GE-502, VHF SIGNAL GENERATOR

SPECIFICATIONS

1. Frequency characteristics
   Range: 455 kHz to 129.999 MHz (8 to 110 MHz for FM).
   Display: Numerical display using 6-digit LEDs.
   Settings: Decade dial settings, 1 kHz steps; frequencies can be remotely controlled by external BCD signals.
   Accuracy: Within $\pm 5 \times 10^{-5}$.
   Stability: Within $\pm 1 \times 10^{-6}$/hour after 2 hours warmup.

2. Output characteristics
   Impedance: 50Ω unbalanced; less than 1.2 VSWR (at less than 110 dBμ); less than 1.3 VSWR (at more than 110 dBμ).
   Level range: −20 to +129 dBμ (open).
   Display: Numerical display using LEDs (1 dB resolution); ±3 dB meter range (0.5 dB resolution).
   Settings: Decade dial settings, 10 dB and 1 dB steps; remote control operation can be accomplished by external BCD signals.
   Level accuracy: Within ±0.5 dB referred to 0 dBμ meter indication and 110 dBμ output attenuator.
   Attenuator accuracy: Within ±1 dB for more than 0 dBμ; within ±2 dB for less than 0 dBμ.
   Spurious: Less than −35 dB for 2nd and 3rd harmonics; less than −75 dB for non-harmonics (less than 119 dBμ output level).
   Connector: N Type.

3. Modulation characteristics
3-1. General:
   Types: FM, AM and simultaneous FM-AM.
   - FM-AM, internal; can be done in different frequencies
   - FM-AM, external
   - FM, internal−AM, external
   - AM, internal−FM, external

   Internal modulation frequency: 400 Hz and 1 kHz, ±(2% + 5 Hz) accuracy.
   External modulation input impedance: 75Ω and 600Ω unbalanced; ±10% accuracy.
   External modulation input connector: BNC Type.

3-2. FM:
   Frequency deviation: 0 to ±200 kHz.
   Indication: Peak indication, 0 to ±50/100/200 kHz; accuracy, ±3% of full scale.
   Input level: Approx. 1 Vp-p for ±75 kHz deviation.
   Frequency range: 30 Hz to 135 kHz.
   Frequency response: Within ±0.3dB referred to 1 kHz.
   Distortion: (8 to 110 MHz carrier frequency and ±75 kHz frequency deviation.) Less than 0.1% for 50 Hz to 60 kHz; less than 0.5% for 30 Hz to 100 kHz.
   S/N ratio: (8 to 110 MHz carrier frequency and ±75 kHz frequency deviation.) More than 75 dB for 30 Hz to 135 kHz demodulation band and 50μs deemphasis ON; more than 68 dB for 50μs deemphasis ON on FM stereo L and R outputs.
   L/R separation: (8 to 110 MHz carrier frequency and ±75 kHz frequency deviation.) More than 50 dB for 100 Hz to 10 kHz; more than 40 dB for 50 Hz to 15 kHz.
   Incidental AM: Less than 0.5% at ±75 kHz deviation.

3-3. AM: (Specifications apply to less than 119 dBμ output level and 0 dBμ output level meter indication.)
   Modulation rate: 0 to 80%.
   Indication: Peak indication, 0 to 50/100%; accuracy, ±5% of full scale (for 0 to 80% modulation rate).
   Input level: Approx. 1 Vp-p for 80% modulation.
   Frequency range: 30 Hz to 15 kHz.
   Frequency response: Within ±1 dB referred to 1 kHz.
   Distortion: Less than 0.7% for 30 Hz to 5 kHz and 30% modulation; less than 1% for 5 to 15 kHz and 30% modulation; less than 3% for 30 Hz to 10 kHz and 80% modulation.
   S/N ratio: More than 60 dB for 30 Hz to 15 kHz demodulation band and 30% modulation.
   Incidental FM: Less than ±50 Hz deviation for 30% modulation and 400 Hz modulation frequency.

4. General
   Power requirements: 100V AC, 50/60 Hz; approx. 100 VA.
   Dimensions: Approx. 200(H) x 425(W) x 300(D) mm.
   Weight: Approx. 20 kg.
   Accessories supplied: Output cable (2m long) terminated on both ends with N connectors.

SYNTHESIZED SIGNAL GENERATOR
TYPE GE-503

- *For Design, Adjustment and Maintenance of Radio Equipment (Transmitters and Receivers)*
- *Wide Frequency Range of 1—520 MHz*

- **Frequency synthesizer type**
- **FM, AM, and pulse modulation**

The GE-503 is a synthesized FM-AM signal generator which employs a PLL system to ensure better frequency stability. The output signal has excellent frequency accuracy, constant amplitude and low spurious response. The GE-503 is the ideal signal source for high-accuracy measurement of characteristics of radio equipment, radio channels, signal filters, and other electronic devices and components.

FEATURES

- **High accuracy, stable output signal:**
  The GE-503's frequency synthesizer guarantees an output signal with high frequency stability and accuracy of 1 x 10^{-5} (typical figures are often better), thereby enabling accurate measurement of even very sharp selectivity characteristics.
- **FM, AM and pulse modulation suitability:**
  A large ON-OFF ratio makes pulse modulation possible.
- **Simple frequency setting:**
  With digital thumbwheel switches, frequency setting is straightforward and accurate. The minimum setting increment is as fine as 1 kHz.
- **Thin-type instrument:**
  The GE-503 employs a thin-type design, providing a good stability and easy handling.

TYPE GE-503, SYNTHESIZED SIGNAL GENERATOR

SPECIFICATIONS

1. Frequency

Range:	1 to 520 MHz (8 to 520 MHz for FM signal)
Setting:	With digital thumbwheel switches, 1 kHz steps. Remote control possible with BCD signal.
Accuracy:	$\pm 1 \times 10^{-5}$ or better.
Stability:	$\pm 1 \times 10^{-6}$/hour or better (after a 2-hour warmup).

2. Output

Impedance:	50Ω, unbalanced. (with VSWR 1.2 or less and output attenuator at 100 dBμ (−10 dBm)
Level range:	−20 to +123 dBμ open circuit (−133 to +10 dBm).
Level setting:	10 dB steps, and continuously variable adjustment.
Level accuracy:	±1 dB or better, with meter indication at 0 dBμ (−3 dBm), and output attenuator at 110 dBμ (0 dBm).
Attenuator accuracy:	±1 dB or better, at 0 dBμ (−110 dBm) or over. ±2 dB or better, at less than 0 dBμ (−110 dBm).
Indicating meter accuracy:	±1 dB or better, with 0 dBμ (−3 dBm) reference.
Spurious:	Harmonics: − 30 dB or less (at 10 MHz or over). − 20 dB or less (at less than 10 MHz). Non-harmonic: − 60 dB or less.
Radiated interference:	No effect on the output level
Connector:	N type, female

3. Modulation

Types	FM, AM, pulse modulation, and simultaneous FM–AM modulation. FM–AM internal modulation (modulation with different frequencies) FM–AM external modulation FM (internal modulation)–AM (external modulation) AM (internal modulation)–FM (external modulation)
Internal modulation frequencies:	400 Hz and 1 kHz, accuracy ±2% or better.
External modulation input impedance:	600Ω, unbalanced, accuracy ±10% or better.
External modulation input connector:	BNC type.

■ FM

Frequency deviation:	0 to ±100 kHz.
Indication:	Peak value indication, 0 to ±10/100 kHz.
Indication accuracy:	Within ±5% of full scale.
Input level:	1 Vp-p or less (for ±100 kHz deviation)
Modulation frequency range:	30 Hz to 135 kHz.
Modulation frequency characteristics:	Within ±0.5 dB (1 kHz reference).
Distortion:	0.3% or less (at 30 Hz to 20 kHz). 0.5% or less (at 20 to 100 kHz) for carrier frequency 8 to 520 MHz, frequency deviation ±100 kHz.
S/N ratio:	65 dB or over (frequency deviation ±100 kHz, demodulation bandwidth 30 Hz to 135 kHz, with 50 μsec de-emphasis), for carrier frequency 8 to 520 MHz.
Incidental amplitude modulation:	0.1% or less (with modulation signal 1 kHz, frequency deviation ±100 kHz).

■ AM

The following specifications are allowed at output level 110dBμ (0 dBm) or less, output level indication meter 0dBμ (−3dBm)

Modulation factor:	0 to 80%.
Indication:	Peak value indication, 0 to 50/100%.
Indication accuracy:	Within ±5% of full scale (modulation factor 0 to 80%).
Input level:	1 Vp-p or less (modulation factor 80%).
Modulation frequency range:	30 Hz to 15 kHz.
Modulation frequency characteristics:	Within ±1 dB (1 kHz reference).
Distortion factor:	1% or less (modulation factor 30%). 3% or less (modulation factor 80%).
S/N ratio:	60 dB or better (modulation factor 30%, demodulation bandwidth 30 Hz to 15 kHz).
Incidental frequency deviation:	Within ±200 Hz (modulation frequency 1 kHz, modulation factor 30%).

■ Pulse Modulation

Repetition frequency:	30 Hz to 100 kHz.
Pulse width:	2 μsec or greater.
Input level:	TTL level.
Rise/fall time:	1 μsec or less.
ON-OFF ratio:	50 dB or greater (below 200 MHz). 40 dB or greater (at 200 MHz or over) with output level meter at 0 dBμ (−3 dBm).

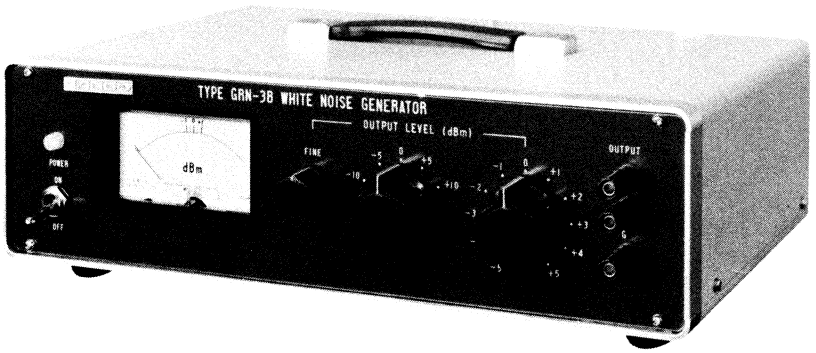
4. General

Power requirements:	100 V AC ±10%, 50/60 Hz; approx. 80 VA.
Ambient temperature:	5 to 35°C.
Dimensions:	Approx. 150 (H) x 425 (W) x 450 (D) mm.
Weight:	Approx. 20 kg.
Accessories supplied:	One (2m long) output cable terminated on both ends with N-type connectors.

WHITE NOISE GENERATORS

TYPES GRN-2/3B

TYPE GRN-2



TYPE GRN-3B

The GRN-2 is a continuous white noise generator designed for use in various noise measurements over the video frequency band.
As the noise frequency is uniformly distributed in the TV picture signal frequency range, this apparatus is especially useful for noise measurement in such devices as amplifiers, transmitters and receivers, modulators, and video recorders.
The GRN-3B is a continuous audio noise generator designed for use in the testing of noise characteristics of communication circuits, communication equipment, audio equipment and suchlike over the audio frequency band.

FEATURES

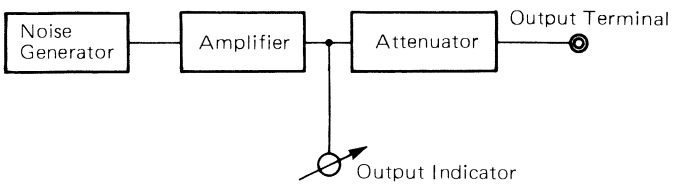
- The noise frequency distribution is broad and flat.
- A far more compact design than conventional noise generators has been realized by the employment of solid-state circuit technology.
- For convenience in outdoor use, an external DC power terminal is provided (Type GRN-2).

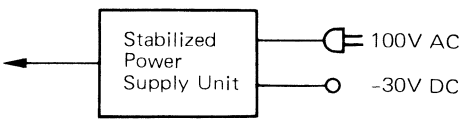
TYPES GRN-2/3B, WHITE NOISE GENEARTORS

SPECIFICATIONS

Type	Type GRN-2	Type GRN-3B
Noise distribution frequency response	15 kHz to 3 MHz; within ±0.5 dB 3 MHz to 10 MHz; within ±3 dB	100 Hz to 10 kHz; within ±1 dB 30 Hz to 20 kHz; within ±2 dB
Output impedance	75 Ω, unbalanced	600 Ω, balanced
Max. noise output	-10 dB into 75 Ω over the frequency range of 15 kHz to 10 MHz. 0 dB = 75 Ω, 1V (RMS value)	+15 dBm
Variable output range	-10 to -60dB (10 dB x 5, 1 dB x 10) over the frequency range of 15 kHz to 10 MHz. ±1 dB fine adjustment possible. Output level control has a scale of from -60 to -110 dB/ 100 Hz.	-15 to +15 dBm (5 dB x 4, 1 dB x 10) ±1 dB fine adjustment possible.
Power requirements	100 V AC, 50/60 Hz or -30 V DC	100 V AC, 50/60 Hz
Dimensions (HxWxD)	Approx. 110 x 360 x 240 mm	Approx. 100 x 350 x 200 mm
Weight	Approx. 6 kg	Approx. 6 kg

BLOCK DIAGRAM (Type GRN-2)





Noise that is generated by the noise generator is amplified by the amplifier and adjusted to a desired output level by the attenuator before delivered to the output terminal. The noise output can be monitored by the output indicator.

2 LEVEL/SELECTIVE LEVEL METERS & STANDARD LEVEL CALIBRATION SET

GENERAL INFORMATION

LEVEL MEASURING SETS

Level meters are designed to measure power levels of signal energy in communications circuits and equipment. The power level is expressed in dBm, 0 dBm corresponding to 1 mW. General-purpose level meters are provided with several varieties of input impedance characteristics in order to be able to match with various impedance systems of circuits undergoing test.

Level meters are generally called flat level measuring sets. They detect a signal within a particular band without selecting any specific frequency and indicates the level of the signal.

In the level meter with balanced input impedances, a transformer is used in the input circuit to form a balanced circuit. It is not affected by external noise (e.g., power line noise) so that highly accurate level measurement is achieved. The balanced circuit type level meter can also be used as an unbalanced type level meter by shorting one of the input terminals to ground.

Each level meter also has the HIGH input impedance capability so that the matching load line (or circuit) can be branched to the level meter in level measurement without disconnecting the load.

The voltage at 1 mW (0 dBm) for each impedance system is as follows.

600Ω, 0 dBm ····· 0.775V
150Ω, 0 dBm ····· 0.387V
75Ω, 0 dBm ····· 0.274V

Three types of level meters for general-purpose applications are available from Ando.

TLM-35B
TLM-36B
AD-4730

These level meters offer the following advantages.

- These level meters also perform the functions of the amplifier (of AC output) and recorder preamplifier (of DC output).
- Type TLM-35B and TLM-36B Level Meters are designed to be operated from internal dry battery power as well as AC line power. Further, as they are compactly designed and light in weight, they can be easily carried to use anywhere.
- Type AD-4730 Level Meter employs an automatic scale expension system, a function for automatic switching of the meter reading to spread scale at the range of 0 dBm ±1 dB, which ensures accurate and easy measurement. The input circuit of the AD-4730 can also be used as an impedance converter.

SELECTIVE LEVEL METERS

Selective level meters are used to measure power levels of signal energy of any disired frequency in communications circuits and equipment, differentiating the frequency from other complex frequencies.

Like the flat level meters the selective level meters also have all kinds of input impedances (600Ω, 75Ω, etc.) to match line impedances. The power level is expressed in 0 dBm, 0 dBm corresponding to 1 mW for all matched impedances. However, the selective level meter differs from the flat level meter in that the selective level meter converts the input signal frequency to a fixed intermediate frequency through the use of a local oscillator prior to level measurement. (Selective level meters generally incorporate a local oscillator, but some types may need an external local oscillator.) Accordingly, the function of level measurement by the selective level meter does not differ from the flat level meter, but the selective level meter has the outstanding advantage of differentiating the desired frequency from other complex frequencies.

This enables the selective level meter serve various purposes as described below:

- Frequency spectrum analysis
- Distortion measurement
- Low level measurement

In general flat level meters low level measurement cannot be made below −60 to −70 dBm on account of internal noise (thermal noise), while in selective level meters levels as low as −100 to −110 dBm can be measured by narrowing the IF band.

The selective level meter is capable of differentiating the desired frequency (e.g., noise level of an idle channel or pilot signal) from complex frequencies contained in, for instance, multi-channel carrier telephone system and accuracy measuring the level of that signal.

From Ando are available various types of selective level meters which are provided with such capabilities as automatic scale expansion, AFC selection, synchronous measurement and highly accurate measurement.

Type AD-2430, AD-2530, AD-2630 and AD-2730 Selective Level Meters are provided with a five-digit electric counter to measure the frequency of interest with high accuracy.

Synchronous Measurement

All selective level meters from Ando are designed for synchronous frequency selection when combined with the Ando's corresponding frequency synthesizers or oscillators. When the local oscillator (variable frequency dial) is

disconnected from the selective level meter and the frequency synthesizer or local oscillator is connected in its stead, transmission measurements can be easily made simply by setting a frequency on the frequency synthesizer or oscillator.

The selective level meters, such as AD-2430 (20 Hz to 20 kHz), AD-2530 (200 Hz to 200 kHz), AD-2630 (800 Hz to 2 MHz) and AD-2730 (10 kHz to 30 MHz), can make easy transmission measurements simply by setting a frequency on their local oscillator (variable frequency dial), when they are operated in conjunction with a synchronous oscillator (like AJ-7430 or AJ-7730).

Selective Level Measurement and Flat Level Measurement

Types AD-2430, AD-2530, AD-2630 and AD-2730 Selective Level Meters also perform the function of the flat level meter. If this capability is not provided, the frequency dial must be turned from one extreme to the other when measuring an unspecified frequency signal or detecting the presence of a signal apart from frequency.

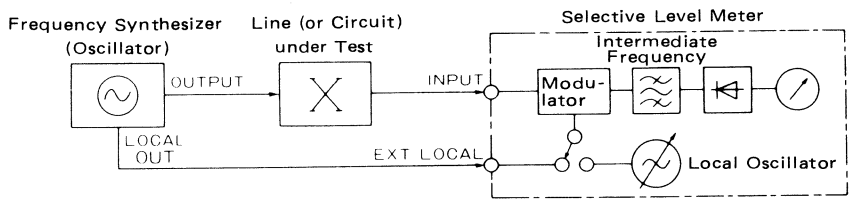
This problem has been solved by providing this series of Ando selective level meters with flat level measurement capability. Further, the measurement of the overall level over the entire frequency range of lines (or circuits) undergoing test can also be made with ease.

Wider Frequency Range and Automatic Measurement Capability

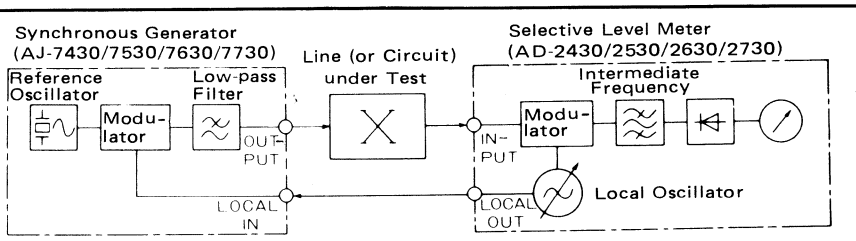
The frequency range of selective level meters is determined by the band ratio of the local oscillator. In conventional selective level meters the band ratio is of the order of about 1000.

However, through the use of a frequency synthesizer as a local oscillator, the band ratio can be easily increased to about 30000. In the AD-2750 Selective Level Meter the frequency range has been widened through the use of 30 MHz 8-digit frequency synthesizer.

In the conventional selective level meters the frequency dial and attenuator are manually set in order to obtain a maximum indicator pointer deflection. In this respect a significant improvement has been realized in the AD-2750 Selective Level Meter. The automatic ranging capability by the use of a microprocessor in the AD-2750 enables a high efficiency of measurements.



Setup for Synchronous Measurement with the Frequency Synthesizer (or Oscillator)



Setup for Synchronous Measurement by AD-2430/2530/2630/2730 with a Special Synchronous Generator

SELECTIVE LEVEL METER-GENERATORS

When making transmission measurements such as gain and loss measurements in communications lines, communication equipment and electronic circuits and parts through the use of a combination of an oscillator and a level meter, a selective level meter is more advantageous than a flat level meter in points of the level measurement range and accuracy.

However, when a separately designed oscillator and a selective level meter (conventional, ordinary type instruments which are not provided with a synchronous frequency selection capability) are combined in such transmission measurements, it is necessary to first set a frequency on the oscillator and then search the same frequency on the selective level meter. It is not uncommon that it takes a lot of time to find the frequency on the selective level meter. It is more so with the selective level meter of high selectivity which is capable of a low level measurement. Further, it is also difficult to have the level meter tuned to the frequency

GENERAL INFORMATION

so detected.
This inconvenience has been solved in Ando's Type AD-7430, AD-7530, AD-7630 and AD-7730 Selective Level Meter-Generators. This series of selective level meter-generators provide for efficient transmission measurements.
The selective level meter-generator of this series consists of an exclusive synchronous generator and a selective level meter. The synchronous generator which receives a signal of local oscillation from the selective level meter performs the function of a beat oscillator. Accordingly, the output frequency of the synchronous generator equals the frequency set by the selective level meter.
In this instrument it is therefore unnecessary to manipulate the frequency dials of both the generator and selective level meter. Simply by setting the frequency dial of the selective level meter the signal of the desired frequency can be applied to a circuit undergoing test and the level of the signal from the circuit can be indicated on the selective level meter.
Since the purpose can be met by manipulating only one frequency dial and it is not necessary to find the frequency on the selective level meter, the efficiency of transmission measurement is quite high in this series of selective level meter-generators. This advantage will be particularly pronounced when making transmission measurements at various frequencies.
The frequency dials of all models are motor-driven for automatic fast tuning. This automatic fast tuning capability is very convenient when grasping the outline of transmission characteristics of the whole measurement frequency range in short periods of time. The efficiency of transmission measurement by this specially-designed selective level meter-generators is by far higher than that which can be achieved by a combination of a separately designed oscillator and a selective level meter.

Separate Use of the Component Units

Of the two component units, the selective level meter can be used as an independent measuring set of high accuracy and efficiency. Further, as it can be used in conjunction of Ando's frequency synthesizers, transmission measurements of still higher accuracy can also be made through combination of them.
The synchronous generator used in the selective level meter-generator cannot be used independently. However, when it is combined with the selective level meter, it gives high performance as a signal generator of high frequency accuracy and output level stability in various tests.

Component Unit Combinations

Four types of selective level meter-generators are available from Ando: AD-7430, AD-7530, AD-7630 and AD-7730 which cover different frequency ranges respectively. Each of them consists of a synchronous generator and a selective level meter. The combinations and designations of these component units are shown below. The component units are housed in separate cases or in one case together.

Frequency Range		20 Hz to 20 kHz	200 Hz to 200 kHz	800 Hz to 2 MHz	10 kHz to 30 MHz
Selective Level Meter-Generator		AD-7430	AD-7530	AD-7630	AD-7730
Component Units	Synchronous Generator	AJ-7430	AJ-7530	AJ-7630	AJ-7730
	Selective Level Meter	AD-2430	AD-2530	AD-2630	AD-2730
Single Case Type		AD-7430-A	AD-7530-A	AD-7630-A	AD-7730-A

CONFIGURATION

SELECTIVE LEVEL METER-GENERATOR

SYNCHRONOUS GENERATOR

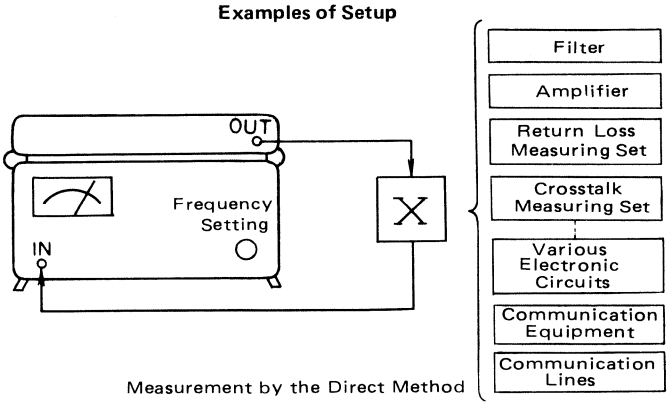
SELECTIVE LEVEL METER

GENERAL INFORMATION

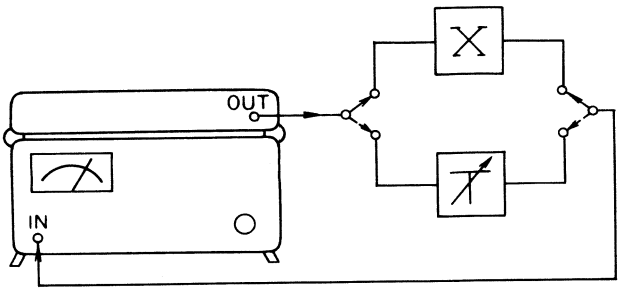
Features

- The selective level meter-generators of this series have the capability for automatic selection of an optimum rate of resolution. When the meter deflection reaches near 0 dBm, the meter scale is automatically expanded, permitting direct reading of changes down to 0.02 dBm. This automatic scale expansion capability permits highly accurate, efficient measurements.
- As the measuring signal is highly stable with respect to both frequency and level, transmission measurements such as steep characteristic curves can also be made easily.
- The frequency of up to 5 digits is measured by an electronic counter and indicated digitally. This electronic counter permits easy, accurate reading.
- The frequency dial can be manipulated both manually and automatically. In the automatic mode the frequency dial is motor-driven. This feature helps greatly to achieve high efficiency of measurement.
- As this selective level meter-generator also performs the function of a flat level meter, it finds use in a far larger number of applications than the selective level meter does alone.

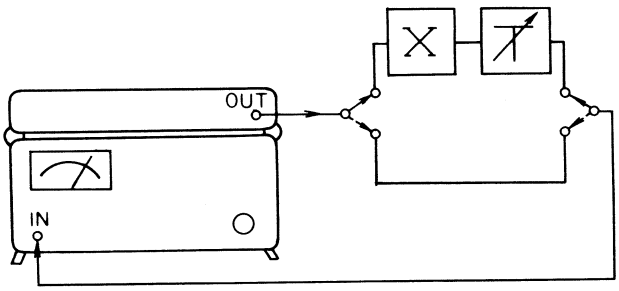
Examples of Setup



Measurement by the Direct Method



Measurement (Loss) by the Comparison Method

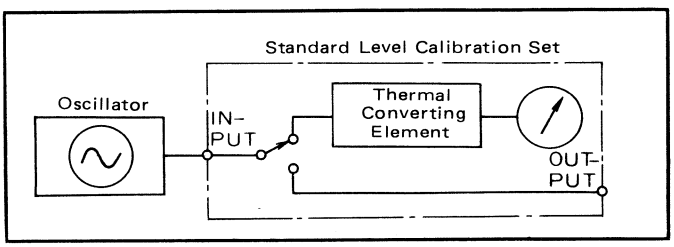


Measurement (Gain) by the Comparison Method

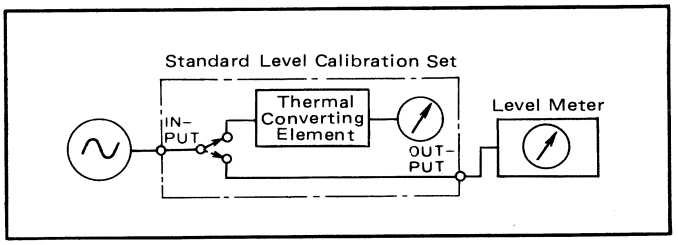
STANDARD LEVEL CALIBRATION SET

A standard level calibration set is a kind of precision wattmeter. In this instrument the meter reading by DC is compared with that by AC through a thermal converting element (e.g., thermocouple) for the purpose of signal level calibration.

The AD-4030 Standard Level Calibration Set is used mainly in the oscillator and signal generator output level calibration and level meter calibration. It is designed so as to be able to deliver a level-calibrated signal as a reference signal.



Oscillator Calibration



Level Meter Calibration

LEVEL METER
TYPE AD-4730

- *Wide frequency range—10 Hz to 30 MHz*
- *Employs automatic expander system for level indicating meter*

The AD-4730 is capable of performing accurate, efficient power level measurements over a wide frequency range from the voice band to the video band. Measurements are made with 0 dBm = 1mW as the reference power level. A dB meter is provided with a normal range and an expansion range. The meter deflection is automatically changed from normal mode to expansion mode when measured level is within 0 dB ±1 dB (automatic expander system).
The AD-4730 also gives excellent performance as a component unit of Type AH-4730D Transmission Measuring Test Set, when operated in conjunction with Ando's Type AJ-2730 Frequency Synthesizer and Type AL-5730 Switching Unit.

FEATURES

- Wide frequency range
- Precise measurements can be easily made over a wide frequency range by using the automatic mode function (from normal to expansion range) of the indicating meter.
- Multiple impedance selection
- Also serves as an amplifier.
- DC output is available for recorder connection.
- Also serves as an impedance converter.
- Small and compact.

This photo shows the AH-4730D Transmission Measuring Test Set which employs the AD-4730.

TYPE AD-4730, LEVEL METER

SPECIFICATIONS

Frequency range		10 Hz to 20 MHz (input A), 10 Hz to 30 MHz (input B)
Input impedance	Input A	600Ω/high, balanced; 0.3 to 150 kHz 150Ω/high, balanced; 10 to 650 kHz 75Ω/high, balanced; 10 to 650 kHz 75Ω/high, unbalanced; 10 Hz to 20 MHz
	Input B	75Ω unbalanced, 10 Hz to 30 MHz
Level meter section	Measurement range	Input A: −70 to +22 dBm (−60 to +20 dBm using level indicating dials) Input B: −70 to +2 dBm (−60 to 0 dBm using level indicating dials)
	Measurement accuracy (0 dB reference)	Input A: ±0.2 dB, 20 Hz to 6 MHz ±0.3 dB, 10 Hz to 10 MHz ±0.5 dB, 10 to 20 MHz Input B: ±0.3 dB, 20 Hz to 6 MHz ±0.4 dB, 10 Hz to 10 MHz ±0.7 dB, 10 to 20 MHz ±1.0 dB, 20 to 30 MHz
	Indication stability	±0.05 dB including line voltage variations of ±10%
	Indicating meter	Normal scale: −10 to +2 dBm. Expansion scale: ±1 dBm
Amplifier section	Gain	0 to 60 dB in 1 dB steps
	Gain accuracy	Input A: ±0.2 dB, 20 Hz to 6 MHz ±0.3 dB, 10 Hz to 10 MHz ±0.5 dB, 10 to 20 MHz Input B: ±0.3 dB, 20 Hz to 6 MHz ±0.4 dB, 10 Hz to 10 MHz ±1.0 dB, 10 to 30 MHz
	Gain stability	±0.05 dB including line voltage variations of 10%
	Maximum output	+2 dBm into 75Ω load
	Output impedance	75Ω unbalanced
	Noise level	−73 dBm or less (with reference to input level)
	Harmonic distortion (2nd and 3rd)	Input A (at max. output): −35 dB or less Input B (at max. output): −35 dB or less, 10 Hz to 20 MHz −30 dB or less, 20 to 30 MHz
DC output		1V±3% into 100 kΩ load (0 dB reference)
Power requirements		100V AC±10%, 50/60 Hz; approx. 12 VA
Dimensions		Approx. 100(H) x 350(W) x 250(D) mm
Weight		Approx. 5 kg
Accessories supplied		One balancing cable (1.5 m long, terminated on both ends with I-214 connectors) One coaxial cable (1.5 m long, terminated on both ends with BNC connectors) One U-link

LEVEL METERS
TYPE TLM-35B/36B

- *Serve as amplifiers*
- *Recorder output*
- *AC or battery operation*
- *Small & compact*
- *Economically priced*

TYPE TLM-36B
10Hz to 20kHz

TYPE TLM-35B
200 Hz to 2 MHz

SPECIFICATIONS

Type		TLM-36B	TLM-35B
Frequency range		10 Hz to 20 kHz	200 Hz to 2 MHz
Measurement range		−60 to +30 dBm	
Dial scale		−5 to +5 dB in 1 dB steps; −25 to +25 dB in 5 dB steps; −30/0 dB	
Input impedance		600Ω and high, balanced	600Ω and high, balanced (0.2 to 150 kHz) 75Ω and high, balanced (5 kHz to 2 MHz)
Frequency characteristics		±1 dB (10 to 20 Hz) ±0.5 dB (20 Hz to 20 kHz)	±0.5 dB (200 Hz to 1 MHz) ±1 dB (1 to 2 MHz)
As amplifier	Maximum output	1V or more (terminated into 600Ω)	0.5V or more (terminated into 600Ω) 0.3V or more (terminated into 75Ω)
	Gain and deviation	60 dB (max.) ±1 dB	51 dB (max.) ±1 dB (600Ω) 60 dB (max.) ±1 dB (75Ω)
	Output impedance	100Ω or less	100Ω or less
	Distortion attenuation	30 dB or more at 1 kHz	30 dB or more at 100 kHz
DC output (as pre-amplifier for recorder)		0.08V or more (terminated into 10 kΩ)	0.1V or more (terminated into 10 kΩ)
Power requirements		100V AC, 50/60 Hz or internal 12V DC (UM-3A x 8)	
Dimensions (HxWxD)		Approx. 150 x 280 x 175 mm (including panel cover)	
Weight		Approx. 3 kg (including panel cover)	
Accessories supplied		Dry cells	

SELECTIVE LEVEL METERS

TYPES AD-2430/2530/2630/2730

Operating over a wide frequency range (20Hz to 30MHz)

- *Selective and flat level measurement capabilities*
- *Automatic expansion scale for high resolution measurements*
- *Synchronous frequency selection over the range of 20 Hz to 30 MHz (by using optional synchronous generators)*
- *Digital display of a selected frequency*
- *Automatic frequency control (AFC)*

TYPE AD-7430 SELECTIVE LEVEL METER-GENERATOR

TYPE AD-2730 (10 kHz to 30 MHz)

EXCELLENT PERFORMANCE

Multi-purpose

- These selective level meters can serve as flat level meters. They also can serve as beat generators, when used with a special synchronous generator (option).

High Resolution

- Because a ±0.5dB expansion scale is employed, small level differences down to 0.02dB can be measured.

High Stability

- All models of this series are provided with an AFC function.

High Efficiency

- Highly accurate measurements are automatically made, as this series is provided with an automatic scale expansion function.
- When used with a special synchronous generator, the level meter is automatically synchronized so that even an unskilled operator can make fast and accurate measurement just by setting a frequency selecting dial. The combinations of synchronous generators and level meters are shown below.

Furthermore, the AD series of selective level meters has many other features including digital readout and AC/DC outputs.

COMBINATION TABLE

Combination name		AD-7430/7430-A*	AD-7530/7530-A*	AD-7630/7630-A*	AD-7730/7730-A*
		Selective level meter-generator			
Frequency range of combination		20 Hz to 20 kHz	0.2 to 200 kHz	800 Hz to 2 MHz	10 kHz to 30 MHz
Components	Selective level meter	AD-2430	AD-2530	AD-2630	AD-2730
	Synchronous generator	AJ-7430	AJ-7530	AJ-7630	AJ-7730

* Each combination of the AD-7430-A/7530-A/7630-A/7730-A is of single case type, and incorporates the level meter and the generator into a portable combining case. The module instruments of the combination can not be used removed from the combining case. On the other hand, each combination of the AD-7430/7530/7630/7730 is composed of two separate cases.

TYPES AD-2430/2530/2630/2730, SELECTIVE LEVEL METERS

SPECIFICATIONS, SELECTIVE LEVEL METERS

Type		AD-2430	AD-2530	AD-2630	AD-2730
Frequency range		20 Hz to 20 kHz	Selective: 0.2 to 200 kHz Flat: 50 Hz to 200 kHz	Selective: 800 Hz to 2 MHz Flat: 200 Hz to 2 MHz	Selective: 10 kHz to 30 MHz Flat: 1 kHz to 17 MHz
Frequency accuracy		± (1 x 10^{-4} +2 Hz), 5-digit	± (1 x 10^{-4} + 20 Hz), 5-digit	± (1 x 10^{-4} + 200 Hz), 5-digit	± (1 x 10^{-4} + 2 kHz), 5-digit
Measurement range		Selective measurement: −100 to +30 dBm (−115 to +32 dBm including meter range) Flat measurement: −60 to +30 dBm (−75 to +32 dBm including meter range)			
Frequency response		±0.5 dB (typical at 0 dBm)			
Selectivity	Passband width	Approx. 10 Hz	Approx. 20 Hz	Approx. 400 Hz	Approx. 3.1 kHz
	Attenuation	±20 Hz, 55 dB or more	±60 Hz, 55 dB or more	±800 Hz, 55 dB or more	±4kHz, 55 dB or more
Input impedance		600Ω/high, balanced 600Ω/high, unbalanced	600Ω/high, balanced 0.3 to 150 kHz 150Ω/high, balanced 4 to 200 kHz 75Ω/high, balanced 4 to 200 kHz 75Ω/high, unbalanced 50 Hz to 200 kHz	600Ω/high, balanced 0.3 to 150 kHz 150Ω/high, balanced 4 to 650 kHz 75Ω/high, balanced 4 to 650 kHz 75Ω/high, unbalanced 200 Hz to 2 MHz	150Ω/high, balanced 4 to 650 kHz 75Ω/high, balanced 4 to 650 kHz 75Ω/high, unbalanced 1 kHz to 30 MHz
Indicating meter		−15 to +2 dBm, ±0.5 dBm spread scale provided (0.02 dBm resolution)			
Power requirements		100V AC, 50/60 Hz. Power consumption (manual mode): approx. 10 VA except for AD-2730 (approx. 17 VA)			
Dimensions & weight		Approx. 200H x 425W x 300D mm. Approx. 15 kg			
General		Permit synchronous operation when used in conjunction with Ando's frequency synthesizers. High impedance probe is available as an option (AD-2730 only).			

SPECIFICATIONS, SYNCHRONOUS GENERATOR OPTIONS*

Type	AJ-7430	AJ-7530	AJ-7630	AJ-7730
Matching selective level meter	AD-2430	AD-2530	AD-2630	AD-2730
Frequency range	20 Hz to 20 kHz	0.2 to 200 kHz	800 Hz to 2 MHz	6 kHz to 30 MHz
Frequency accuracy	± (1 x 10^{-4} + 2 Hz)	± (1 x 10^{-4} + 20 Hz)	± (1 x 10^{-4} + 200 Hz)	± (1 x 10^{-4} + 2 kHz)
Output impedance	600Ω unbalanced/balanced	600Ω balanced 0.3 to 150 kHz 150Ω balanced 4 to 200 kHz 75Ω balanced 4 to 200 kHz 75Ω unbalanced 0.2 to 200 kHz	600Ω balanced 0.8 to 150 kHz 150Ω balanced 4 to 650 kHz 75Ω balanced 4 to 650 kHz 75Ω unbalanced 800 Hz to 2 MHz	150Ω balanced 6 to 650 kHz 75Ω balanced 6 to 650 kHz 75Ω unbalanced 6 kHz to 30 MHz
Output level	−60 to +10 dBm. ±1 dBm indicating meter provided (0.2 dBm resolution)			
Distortion attenuation	40 dB or more (typical at +10 dBm)			40 dB or more 6 kHz to 10 MHz 35 dB or more 10 MHz to 30 MHz
Power requirements	100V AC, 50/60 Hz. Power consumption: approx. 7 VA			
Dimensions & weight	Approx. 70H x 425W x 300D mm, approx. 5.5 kg			

* These options serve as an exclusive generator for the AD-2430, 2530, 2630 or 2730 selective level meter.

SELECTIVE LEVEL METER
TYPE AD-2700

● *Wide frequency range from 200Hz to 30MHz*

The AD-2700 is a selective level meter over a wide frequency range from 200 Hz to 30 MHz, and used for telecommunications equipment production, telecommunications line construction and maintenance testings, etc.

FEATURES

- Wide frequency range from 200 Hz to 30 MHz
- Small and compact
- Stable frequency generation (synthesizer), $\pm(3 \times 10^{-5} + 10\ Hz)/0^{\circ}$ to $45^{\circ}C$
- Highly accurate measurements because a calibrated oscillator is employed.
- Having 20 Hz and 1.74 kHz bandpass filters, pilot levels and idle channel noise levels are measurable.
- Can serve as a flat level meter or a psophometer with optional weighting networks.

SPECIFICATIONS

Frequency range: 200 Hz to 30 MHz (selective)
200 Hz to 18 MHz (flat)

Frequency display: 7-digit, LED, minimum 10 Hz

Frequency accuracy: $\pm(3 \times 10^{-5} + 10\ Hz)/0^{\circ}$ to $45^{\circ}C$

Measurement range: -100 to +32 dBm (BW 1.74 kHz)
-115 to +32 dBm (BW 20 Hz)
-75 to +32 dBm (flat)

Meter scale: -15 to +2dB (normal)
-0.5 to +0.5 dB (expansion), minimum scale 0.02 dB

Measurement accuracy:

75Ω, unbalanced:

Level range \ Frequency range	100 kHz	200 Hz to 18 MHz	18 to 30 MHz
0 dBm	±0.1 dB	±0.2 dB	±0.3 dB
+20 to +32 dBm	±0.5 dB		
-80 to +20 dBm	±0.3 dB		±0.4 dB
-100 to -80 dBm	±0.5 dB		
-115 to -100 dBm	±1.5 dB		

100 kHz calibration accuracy (20 Hz bandwidth), low noise function (at 23°C ±5°C).

75/150/600Ω, balanced: Add the compensation value of ±0.2 dB to the accuracy value of unbalanced impedance.

Input impedance:

Impedance	Frequency band	Return loss	Connector
75Ω and high, unbalanced	200 Hz to 30 MHz	30 dB or more (200 Hz to 18 MHz) 20 dB or more (18 to 30 MHz)	BNC
75/150Ω and high, balanced	4 to 650 kHz	30 dB or more	I-214
600Ω and high, balanced	200 Hz to 150 kHz		

Selectivity:

3 dB bandwidth	Attenuation
Approx. 20 Hz	55 dB or more at f_0 ±150 Hz
Approx. 1.74 kHz	55 dB or more at f_0 ±2 kHz

Internal distortion attenuation: 55 dB or more (at LOW DIST function)

Temperature: 0° to 45°C

Power requirements: 100V AC 50/60 Hz

Dimensions: Approx. 130(H) x 350(W) x 400(D)mm

Weight: Approx. 10 kg

Options: Telephone weighting network (P.53)
Program circuit weighting network (P.53)
Front panel cover

SELECTIVE LEVEL METER

TYPE AD-2750B

GP-IB

- *Has digital displays and automatic tuning capabilities.*
- *Covers a wide frequency range from 200Hz to 30MHz.*
- *Capable of performing highly accurate measurement owing to the automatic level calibration capability.*
- *The built-in microprocessor unit enables this level meter to cover a wider range of applications.*
- *The GP-IB capability affords the flexibility for system use.*

The AD-2750B is a microprocessor-based automatic selective level meter ideal for time-saving measurements and a complete system use. It is useful for tests in the manufacture of communications equipment and the construction and maintenance of transmission lines.

USES

- FDM system measurements: line pilot signal level, reference pilot signal level, carrier leakage, crosstalk, channel noise, spectrum analysis, and frequency response measurements.
- Distortion measurements in oscillators, amplifiers, transformers and other instruments.
- Filter attenuation measurements.

FEATURES

- A lot of time required for measurement can be saved when using the frequency memory function (50 frequencies).
- An unknown signal level is automatically tuned in and its frequency and level are displayed digitally.
- The frequency range is as wide as 200 Hz to 30 MHz.
- The local oscillator is of synthesized type.
- The automatic level calibration, and automatic level control capabilities combine to achieve high accuracy in measurement.
- The built-in GP-IB capability (option) facilitates easy system use.
- Flat level measurement over a range of 50 Hz to 30 MHz is possible with the use of a flat level measuring circuit (option).
- Transmission characteristics measurement can be easily made when the AD-2750B is operated in conjunction with the AJ-7750B Synchronous Generator.
- The output data can be visually observed or recorded with the use of a monitor-scope (with GP-IB card option).

TYPE AD-2750B, SELECTIVE LEVEL METER

SPECIFICATIONS

Frequency range	200 Hz to 30 MHz
Frequency display	8-digit LED display in 1 Hz steps
Reference frequency stability	$\pm 1 \times 10^{-5}$/0–45°C (Option: $\pm 1 \times 10^{-6}$ or $\pm 1 \times 10^{-7}$/0–45°C)
Level measurement range	–100 to +30 dBm (Bandwidth: 1.74 kHz, 3.1 kHz) –120 to +30 dBm (Bandwidth: 20 Hz, 200 Hz)
Level display	LED: 5-digit display in 0.01 dB steps
Level display mode	dBm: Absolute value dB: The difference between input level and reference level (The reference level is set with a keyboard.)

Level measurement accuracy

Level range \ Frequency range	200 Hz to 18 MHz	18 MHz to 30 MHz
0 dBm	±0.2 dB	±0.3 dB
–80 to +20 dBm	±0.3 dB	±0.4 dB
–100 to –80 dBm	±0.5 dB	±0.5 dB
–110 to –100 dBm	±1.5 dB	±1.5 dB

Accuracies above apply when the input impedance is 75Ω unbalanced and the bandwidth is 20 Hz with the demodulator off and AFG on. If the input impedance is balanced, ±0.2 dB is added for purposes of correction.

Input impedance

Impedance	Bandwidth	Return loss	Connector
75Ω unbalanced	200 Hz to 30 MHz	30 dB or more (200 Hz to 18 MHz) 20 dB or more (18 MHz to 30 MHz)	BNC
75Ω unbalanced 135Ω unbalanced 150Ω unbalanced	4 kHz to 2 MHz	30 dB or more, 4 to 650 kHz 18 dB or more 650 kHz to 2 MHz	I-214 or equal
600Ω unbalanced	200 Hz to 150 kHz	30 dB or more	

High impedance of the above each impedance

Selectivity

Bandwidth	Passband width	Attenuation
20 Hz	3 dB at approx. 20 Hz	60 dB or more at f_0 ±150 Hz
200 Hz	3 dB at approx. 200 Hz	60 dB or more at f_0 ±1.5 kHz
1.74 kHz	3 dB at approx. 1.74 kHz	60 dB or more at f_0 ±2 kHz
3.1 kHz	3 dB at approx. 3.1 kHz	60 dB or more at f_0 ±4 kHz

Internal distortion attenuation	60 dB or more with reference to: 100 kHz or more; +20 dBm or less, unbalanced; +10 dBm or less, balanced
Image rejection	80 dB or more
Operating temperature	0 to 45°C
Power requirements	100/120/220/240 V AC, 50/60 Hz; 150 VA or less (power consumption excluding options)
Dimensions & weight	Approx. 200 (H) x 425 (W) x 450 (D) mm, approx. 25 kg

OPTIONS (Mounted on the AD-2750B mainframe at the factory.)

No.	Options
01	GP-IB card
02	Reference crystal oscillator circuit 1×10^{-6}/0–45°C
03	Reference crystal oscillator circuit 1×10^{-7}/0–45°C
04	Flat level measuring circuit
05	Telephone weighting network (TEL P53)*
06	Broadcasting weighting network (PROG P53)*
07	Broadcasting weighting network (PROG J16)*
09	Demodulator

* These options need the flat level measuring circuit option (No. 04).

COMPLEMENTARY EQUIPMENT FOR SYSTEM USE

Equipment	Type Number
Desktop Computer	AE-8101 (amics 80 series)
Frequency Synthesizers	AJ-2750B/7750B
Attenuators	AL-4550/4551/4750
Switching Units	AL-5530/5630/5731
Channel Selectors	AL-5570/5571/5770/5771

SELECTIVE LEVEL METER

TYPE SLM-51

- *Frequency range from 1 to 130MHz*
- *Capable of performing synchronous operation when used together with the GES-100 frequency synthesizer*

FEATURES

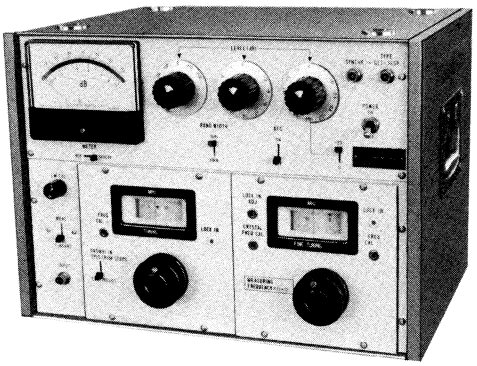
- Synchronous operation when operated in conjunction with the GES-100 frequency synthesizer.
- Selected frequencies are displayed on a 4-digit mechanical counter.
- Frequency selection can be done in either automatic or manual mode.
- AC/DC outputs are provided.
- A ±0.5 dBm expansion scale is employed.

SPECIFICATIONS

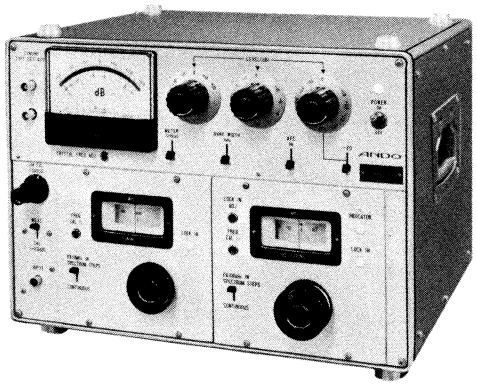
Frequency range:	1 to 130 MHz	
Frequency accuracy:	± (1% + 50 kHz) (5 MHz calibration accuracy)	
Measurement range:	Level measurement: -90 to +20 dBm (-105 to +21 dBm including meter range) Distortion measurement: -90 to 0 dBm	
Frequency response:	±0.5 dB, 3 to 70 MHz ±1 dB, 1 to 130 MHz for indicating meter reading of 0 dBm	
Selectivity:		
Passband width:	Wide band	30 kHz
	Narrow band	3 kHz
Attenuation:	Wide band	40 dB or more, ±100 kHz
	Narrow band	60 dB or more, ±4 kHz
Input impedance:	75Ω unbalanced	
Indicating meter:	-15 to +1 dBm ±0.5 dBm expansion scale provided	
Power requirements:	100V AC, 50/60 Hz; approx. 52VA	
Dimensions:	Approx. 250H x 425W x 300D mm	
Weight:	Approx. 21 kg	

SELECTIVE LEVEL METERS

TYPES SLM-36SP/36N/42SP



TYPE SLM-36SP (1 – 250 MHz)



TYPE SLM-42SP (1 – 1000 MHz)

SPECIFICATIONS

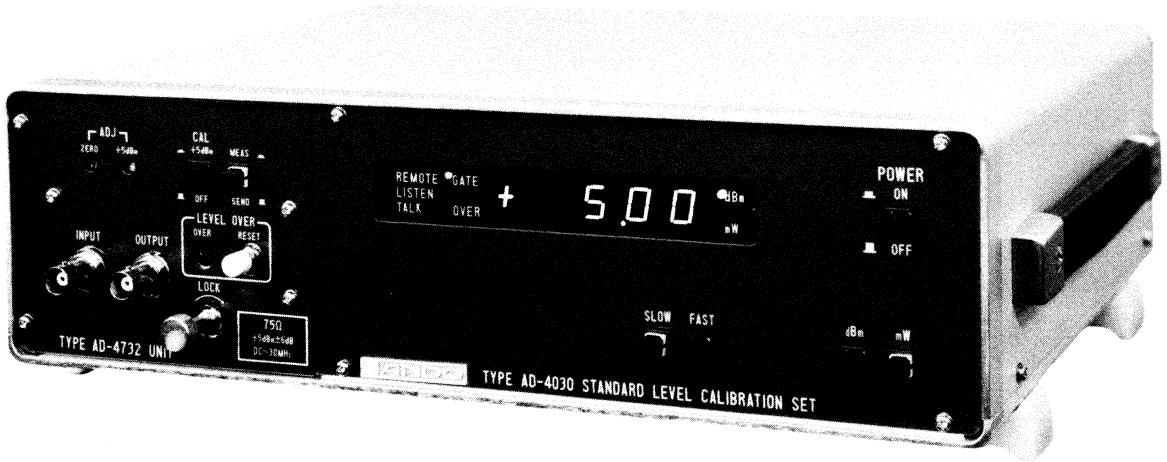
Type		SLM-36SP/SLM-36N	SLM-42SP
Frequency range		1 to 250 MHz	1 to 1000 MHz
Frequency accuracy (after calibration)		± (2 x 10^{-5} + 20 kHz) f_1 (coarse range), locked in 5 MHz spectrum steps f_2 (fine range), continuous	± 5 x 10^{-7}/day f_1 (coarse range), locked in 10 MHz spectrum steps; f_2 (fine range), locked in 100 kHz spectrum steps ± (2 x 10^{-6} + 20 kHz) f_1, locked in 10 MHz spectrum steps; f_2, continuous
Measurement range		–80 to +20 dBm (–90 to +21 dBm with meter range); 10 dB, 1 dB and 0.1 dB dial steps	–80 to +20 dBm (–90 to +21 dBm with meter range); 10 dB, 1 dB and 0.1 dB dial steps
Frequency characteristics (after calibration at 0 dBm)		±1 dB	±1 dB, 1 to 600 MHz (at 0 dBm meter scale) ±2 dB, 1 to 1000 MHz (at 0 dBm meter scale)
Input impedance		SLM-36SP: 75Ω unbalanced Connector: SP female SLM-36N: 50Ω unbalanced Connector: N female	75Ω unbalanced Connector: SP female
Selectivity	Passband width	3 kHz and 30 kHz	3 kHz and 15 kHz
	Attenuation	55 dB or more at ±10 kHz and ±100 kHz	55 dB or more at ±10 kHz and ±100 kHz
Synchronous operation		Possible (with Type GET-36 Oscillator)	Possible (with Type GET-42SP Oscillator)
Power requirements		100V AC, 50/60Hz; approx. 70 VA	100V AC, 50/60 Hz; approx. 66 VA
Dimensions (approx.)		300(H) x 425(W) x 300(D) mm	300(H) x 425(W) x 300(D) mm
Weight (approx.)		29 kg	33 kg
Other description		AC and DC output terminals are provided. A dB meter is calibrated from –10 to +1 dB. It also provides ±0.3 dB spread scale. Small level differences of down to 0.01 dB can be measured on the expanded meter range.	AC and DC output terminals are provided on the rear panel of the instrument. A dB meter is calibrated from –10 to +1 dB. It also provides ±0.3 dB spread scale. Small level differences of down to 0.01 dB can be measured on the expanded meter range.

STANDARD LEVEL CALIBRATION SET

TYPE AD-4030

GP-IB

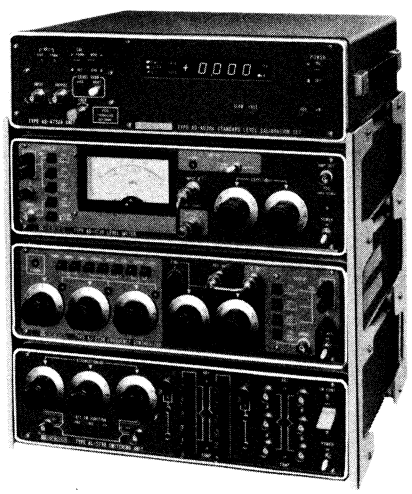
- *For accurate measurements or calibration of power in transmission lines and measuring instruments (oscillators, level meters, etc.).*
- *Plug-in versatility*



The AD-4030 Standard Level Calibration Set is designed for the accurate measurement and calibration of the power level (r.m.s.) in transmission circuits and various instruments, such as oscillators and level meters. The set consists of a mainframe and a plug-in unit. Six plug-in units are offered to meet your measurement needs. Digital display in mW and dBm provides easy readout.

FEATURES

- Level Calibration over Wide Range
  Level calibration can be carried out over the wide range from DC/20 Hz to 1000 MHz through the exchange of the plug-in units.
- High Resolution
  Resolution is as high as 0.01 dB or 0.001 mW.
- Digital display provides easy readout.
- Protection circuit prevents the thermocouple from being damaged by overload input (except for the AD-4930 unit).
- Low profile, high stability, and excellent operability are other features.



The set is designed to be stacked up on the AH-4730D transmission measuring test set as shown in the photo.

TYPE AD-4030, STANDARD LEVEL CALIBRATION SET

SPECIFICATIONS

Unit (plug-in)	AD-4530	AD-4532	AD-4533	AD-4630	AD-4732	AD-4930*
Frequency range	DC and 20Hz to 2MHz		DC and 20Hz to 500kHz	DC and 20Hz to 10MHz	DC and 20Hz to 30MHz	DC and 20Hz to 1000MHz
Impedance	75Ω balanced	150Ω balanced	600Ω balanced	110Ω balanced	75Ω unbalanced	
Connector	For I-214APS			For T-RIS	For BNC	For SP
Return loss	30dB or more					25dB or more
Measurement range	-1 to +11dBm or 0.79 to 12.6mW					-1 to +10dBm or 0.79 to 10mW
Sending level	Same as measured level; sending level accuracy, +0.05dB or less					
Measurement accuracy	(After internal DC calibration) DC accuracy: at +5dBm: ±0.05dB from 0 to +10dBm: ±0.1dB AC accuracy: at +5dBm: ±0.1dB (20Hz to 30MHz) ±0.2dB (20Hz to 1000MHz) from 0 to +10dBm: ±0.2dB (20Hz to 30MHz) ±0.3dB (20Hz to 1000MHz)					
Over load protection circuit	Provided					Not provided
Measurement unit	dBm or mW					
Resolution	0.01dBm or 0.001mW					
Display	4-digit decimal, polarity; over, gate					
Power requirements	100V AC, 50/60Hz; approx. 12VA					
Dimensions	Approx. 100H x 350W x 250D mm					
Weight	Approx. 5kg					
Accessories supplied	One (1m long) measurement cable per plug-in unit					————
Option	Remote control capability (GP-IB)					

* *Composed of the unit itself and the external sensor with one measurement cable (1m long).*

Plug-in units: (from left to right) AD-4533, AD-4732, AD-4930

3 SPECTRUM ANALYZERS

GENERAL INFORMATION

A spectrum analyzer can be considered a tuning frequency swept receiver. However, its peripheral parts differ from those of general receivers. While covering a wide frequency range, the spectrum analyzer provides for direct observation of large dynamic signals on the surface of its CRT. The spectrum analyzer furnishes a lot of information. It is an instrument with a larger number of uses in the frequency domain measurements which favorably compares with an oscilloscope in the time domain measurements.

Ando's spectrum analyzers series listed in this catalog covers the frequency range of 10 Hz to 1700 MHz. It is needless to say that the spectrum analyzer which can cover the widest frequency range possible should be chosen, but there is another important consideration in the selection of spectrum analyzers. That is the necessity or capability of analyzing signals closely spaced in frequency. Generally it is difficult for the spectrum analyzer to have at once wide bandwidth and high resolution. However, these two factors must always be taken into consideration in selecting the spectrum analyzer fit for the purpose.

Resolution

The resolution of the spectrum analyzer is limited by the narrowest of the 3 dB bandwidth of the built-in variable bandpass filters and the passband shape factor. (The variable bandpass filter which is generally located in the intermediate frequency amplifier and referred to as the IF filter.)

In Fig. 1, two signals f_1 and f_2 are equal in amplitude. In this case the spectrum analyzer can detect the presence of two signals even if Δf_1 is very close to 3 dB bandwidth of the IF filter B_3 (Fig. 3).

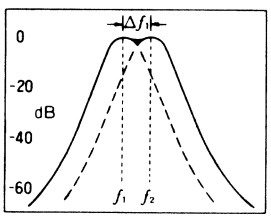


Fig. 1

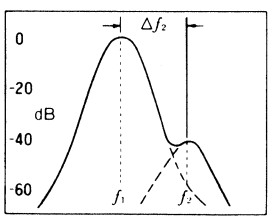


Fig. 2

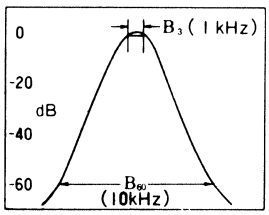


Fig. 3

In Fig. 2, the amplitude of the two signals differs significantly from one signal to the other. (In the case cited the amplitude of one signal is 100 times as big as that of the other.) In this case the small signal is covered by the skirt of the big signal, so that the difference in frequency cannot be resolved unless $\Delta f_2 > \Delta f_1$.

If can be known from Fig. 2 that Δf_2 varies with the skirt characteristics of the filter and the level difference between the two signals. In the spectrum analyzer the ratio of B_{60} (60 dB attenuation width) to B_3 is defined as a shape factor (which indicates the steepness of the attenuation curve). The smaller this value, the higher is the resolution. In Fig. 3 the ratio of B_{60} to B_3 is 10 : 1. In other words, the shape factor is 10.

An optimum filter for the spectrum analyzer is said to be one having Gauss characteristics (filter with the least transient characteristics). However, the theoretical shape factor of Gauss characteristics is $\sqrt{80} \fallingdotseq 9$. The filter of this sort cannot be formed with a finite number of elements. A practical way which is often employed is to use N-stage single-tuned circuits. In this case if N is 3, the shape factor is about 20, and if N is 5, the shape factor is about 10.

A bandpass filter will give the steeper characteristic than the tuned circuits, but has the following disadvantages.

(a) The curve has a flat top. This is not desirable in the instrument which essentially deals with the line spectra.

(b) The transient response is sharp. (This can be remedied, however.)

(c) It is difficult to vary the bandwidth.

(In Ando's frequency spectrum analyzers the tuned circuit is employed for the narrow bandwidth.)

The foregoing explanation may suggest that the narrower B_3 is, the higher is the resolution. The fact is, however, that there are practically limitations on resolution for two reasons.

(1) The spectrum analyzer itself has frequency fluctuations (of short and long term).

(2) The sweep rate must be slow in inverse proportion to the square of B.

Residual FM

The frequency fluctuation which restricts the use of very narrow bandwidth filters is called "residual FM." It occurs when the sweep rate of the spectrum analyzer is not even when analyzed minutely. Since a wide frequency range is achieved where the frequency varies very widely, a wide frequency range is incompatible with the strict limitation on the frequency change.

It is hard to generalize how much frequency variation is allowed, but it may be said that residual FM should be limited to under "bandwidth x shape factor ÷ 25".

The typical values of shape factor and residual FM used in Ando's spectrum analyzers are given in Table 1.

Type Number	Frequency Range	Minimum Band-width	Shape Factor	Residual FM*1
AC-8203A	10 kHz to 500 MHz	100 Hz	About 10	20 Hz (p-p)
AC-8211	100 kHz to 1700 MHz	1 kHz	About 13	3 kHz (p-p)

Table 1. Values of Shape Factor and Residual FM in Ando's Spectrum Analyzers

*1 Residual FM was determined by direct visual observation at the fastest sweep rate using the minimum bandwidth and sweep width when the UNCAL lamp was not lit. Accordingly the values given above do not include slow fluctuation or drift.

Spurious Responses

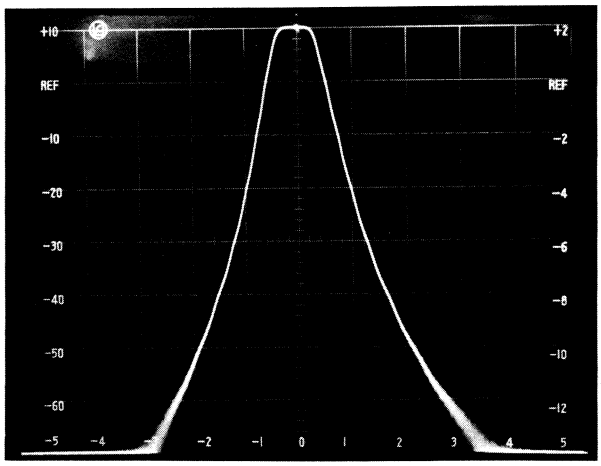
Another important performance parameter of the spectrum analyzer is spurious response.

The spurious response arises from the nonlinear distortion of the spectrum analyzer itself and correlates to the input level. The lower the input level, the less marked is the spurious response. The spectrum analyzer noise being constant (bandwidth fixed), the level of signals which the spectrum analyzer can analyze has a certain range, depending on the relative extent of spurious response and noise. This is generally called a dynamic range. The spectrum analyzer of a large dynamic range furnishes more information.

Transmission Measurement

One application area of the frequency spectrum analyzer is the visual measurement of transmission (frequency and amplitude characteristics). In this area the spectrum analyzer of a large dynamic range proves quite instrumental. In the transmission measurement the spectrum analyzer needs a signal generator which operates in synchronization with the sweep. Some types of spectrum analyzers have a tracking generator as a complementary device.

An example of transmission measurement is shown in Photo 1. (This is a case where the transmission of a bandpass filter having 10.7 MHz as the central frequency is measured. The bright spot at the center indicates the 10.7 MHz frequency marker.)



Vertical axis: 10 dB/DIV
Horizontal axis: 0.5 MHz/DIV

Photo 1. Example of Transmission Measurement (Type AC-8203A)

SPECTRUM ANALYZER
TYPE AC-8203A

TYPE AC-8203A is a wide band spectrum analyzer which covers the frequency range of 10 kHz to 500 MHz, and used for frequency surveillance and level measurements of various signals, such as multiplexed signal, AM signal, FM signal, PM signal, CW signal, random noise, etc.
Using a tracking generator (option) as a signal source, the frequency response measurements on video amplifiers and filters can be also made with this analyzer.

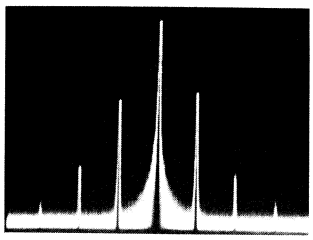
10 kHz to 500 MHz

TYPE AC-8203A (including Tracking Generator)

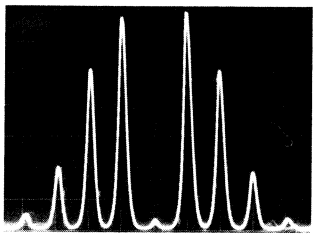
FEATURES

- Wide frequency range from 10 kHz to 500 MHz.
- Because of the excellent stability, it can easily make the frequency response measurements on crystal filters showing steep traces.
- An optional tracking generator with a frequency counter may be incorporated in the analyzer. Frequency measurement may be made with counter accuracy.
- IF band width selector switch includes the AUTO mode to select the optimum rate of resolution for faster measurement. Furthermore, 60 dB/3 dB IF band width ratio is as small as 10:1. This ensures higher resolution.
- Output terminals for a X-Y recorder are provided.
- Internal graticule CRT for parallax-free measurements.

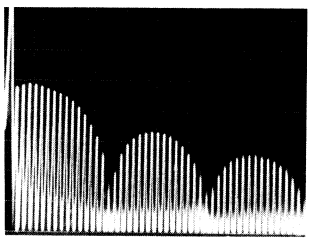
EXAMPLES OF WAVEFORM DISPLAYS



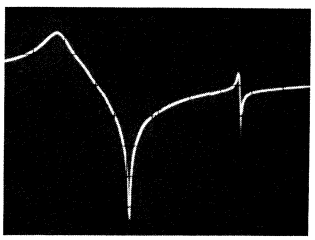
AM Signal



FM Signal



Square Wave Signal



Crystal Resonator

TYPE AC-8203A, SPECTRUM ANALYZER

SPECIFICATIONS

Frequency range:	10 kHz to 500 MHz.
Level measurement range:	−110 to +20 dBm.
Level vs. frequency response:	Within 2 dB deviation (10 kHz to 500 MHz).
Input impedance:	50Ω, BNC (75Ω available as a special order)
Sweep center frequency range:	0 to 500 MHz (continuously variable, one range).
Sweep width:	0 to 500 MHz (preset) and 14 sweep widths from 20 MHz/div to 1 kHz/div in a 1, 2, 5 sequence (per division). Within ±10% accuracy.
Sweep rate:	12 internal sweep rates from 1msec/div to 5 sec/div in a 1, 2, 5 sequence. Within ±20% accuracy.
CRT scale:	10 dB/div (80 dB), 2 dB/div (16 dB), EXPAND (variable from approx. 0.5 to 1.5 dB/div).
CRT phosphor screen:	P7 long persistence type
CRT scale accuracy:	With reference to REF level: Within ±2 dB from −70 to +10 dB (10 dB/div); within ±0.5 dB from −14 to +2 dB (2 dB/div).
IF band width:	AUTO and 0.1 to 300 kHz in a 1, 3 sequence.
IF band width selectivity:	60 dB/3 dB band width ratio: Approx. 13:1 from 10 to 300 kHz; approx. 10:1 from 0.1 to 3 kHz.
Sweep linearity of horizontal axis:	Within ± 5%
Level marker signal:	50 MHz (± 2%); −30 dBm (± 0.5 dB).
Output for recorder:	Video output: Approx. 2 Vp-p Sawtooth wave output: Approx. 10 Vp-p
Tracking generator:	
Frequency range:	0.2 to 500 MHz.
Output level:	−40 to + 10 dBm.
Level vs. frequency response:	Within 2 dB deviation from 0.2 to 500 MHz. Within 0.5 dB deviation in the range of 50 MHz out of the entire range.
Output impedance:	50Ω, BNC (75Ω available as a special order)
Display:	5 digits in 10 kHz resolution.
Power requirements:	AC 100V, 50/60 Hz; approx. 110 VA. (including tracking generator)
Dimensions:	Approx. 250(H) x 425(W) x 450 (D) mm.
Weight:	Approx. 33 kg (including tracking generator).
Options:	Tracking generator, camera (AQ-4501), fixed attenuators, log-periodic antenna.

SPECTRUM ANALYZER
TYPE AC-8211

● *Wide frequency range —100kHz to 1700MHz*

This 100 kHz to 1700MHz wide frequency range spectrum analyzer is designed for diversified uses such as frequency distribution and spurious measurements of various signals as well as their level measurements, and it can conveniently be used for manufacturing and maintenance of the communication equipment and CATV units.

FEATURES

- Wide Frequency Range
- Ease of Operation
  The AUTO range for the resolution bandwidth and sweep time assures effective measurements.
- Plug-in Type
  This analyzer is composed of a display unit and an RF unit, and the plug-in type RF unit features abundant expandability in the future.

TYPE AC-8211, SPECTRUM ANALYZER

SPECIFICATIONS

1. Frequency

Measurement range		100kHz to 1700MHz
Dial indication		Digital indication with START/CENTER selector switch provided
Indicating accuracy		±10MHz
Sweep width	FULL	0 to 1700MHz (200MHz/DIV)
	PER DIV	100MHz/DIV to 20kHz/DIV in a 1, 2, 5 sequence, ZERO
	Accuracy	±10% in PER DIV
Resolution bandwidth characteristics	Bandwidth (3dB bandwidth)	AUTO, 1MHz to 1kHz in a 1,3 sequence. Bandwidth is automatically selected according to the sweep width and sweep rate in the AUTO mode.
	Selectivity	1MHz to 1kHz, approx. 15:1

2. Amplitude

Level vs. frequency characteristics		Deviation: 2 dB or less
Display range on CRT screen	10dB/DIV	−110 to +20dBm/80dB
	1dB/DIV	−88 to +20dBm/8dB
	LIN	0 to 16/8DIV
LOG linearity		±2dB/80dB, ±0.3dB/8dB
Dynamic range	Average noise level	−110 dBm or less Bandwidth: 1kHz, Frequency: 1MHz or more
	Second and third distortion	−70dB or less at an input level of −30dBm Input frequency: 2MHz or more
Video filter		ON, OFF; cut-off frequency is approx. 1/30 of the bandwidth

3. Input Terminal

Impedance		50Ω Type N V.S.W.R.: 1.5 or less (RF attenuator: 10dB or more)
Maximum input level	RF	+20dBm
	DC	0V

4. Sweep

Sweep rate	AUTO, 0.02ms/DIV to 5s/DIV in a 1, 2, 5 sequence The sweep rate is automatically selected according to the sweep width and resolution bandwidth in the AUTO mode
Sweep mode	AUTO, MANUAL
Sweep trigger	FREE RUN, LINE, VIDEO

5. Output Terminal

Calibration signal	100MHz, ±0.01% or less −30dBm, ±0.5dB or less
Recorder output	Video output: approx. 0 to +4V Saw-tooth wave output: approx. −5 to +5V

6. CRT

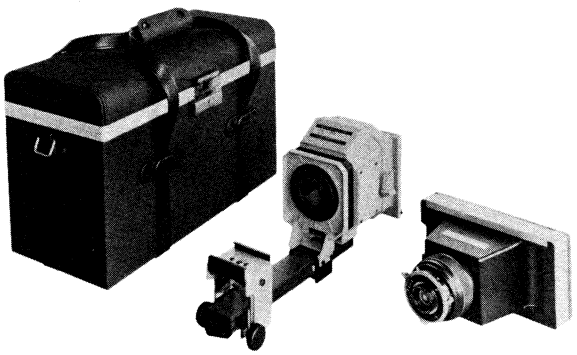
CRT scale	Internal graticule, 8DIV x 10DIV
Phosphor screen	P7 long persistence type

7. General

Power requirements	100V AC, 50/60Hz approx. 85VA
Dimensions and weight	Approx. 200(H)x350(W)x450(D)mm approx. 22kg
Accessories supplied	Measurement cables ..... 2 N (male) • BNC (female) adapter .. 1

8. Options

Camera (AQ-4501), log-periodic antenna, fixed attenuators, amplifier unit (AC-8252), impedance converters, highpass filters.

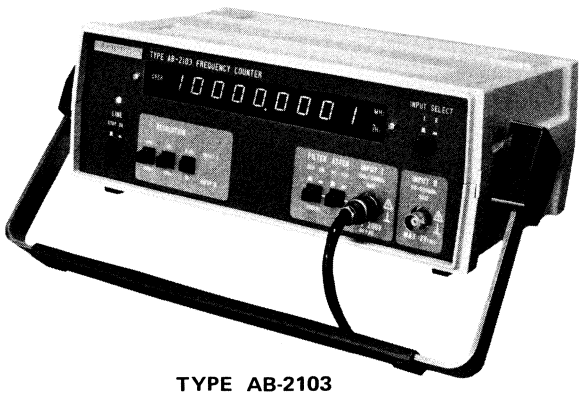


TYPE AQ-4501 CAMERA AND CARRYING CASE

4 FREQUENCY COUNTERS

FREQUENCY COUNTERS
TYPES AB-2103/2104

● *Low cost counters for frequency measurements*
AB-2103····· 10Hz–550MHz
AB-2104····· 10Hz–1000MHz

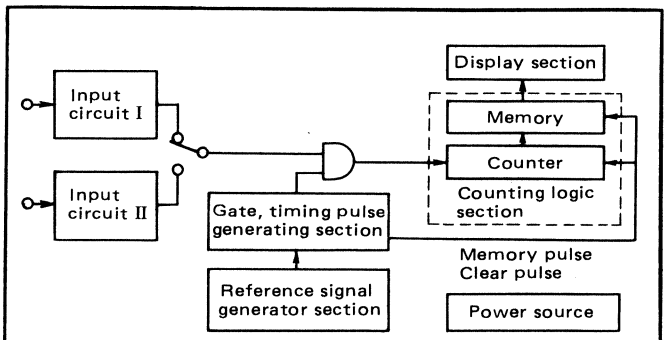


TYPE AB-2103

TYPE AB-2104

Frequency counters are basic instruments for a wide range of uses. The latest counter is quite different from the conventional ones because of the improvement in performance and quality of the semiconductor, especially ICs. Ando's small-sized low power consumption frequency counters which are superior in accuracy and measurement stability are introduced here. Type AB-2104 (10Hz–1000MHz) and Type AB-2103 (10Hz–550MHz) can be widely used for research and development of various electronic equipment, adjustment and inspection in production line, service, and maintenance.

Types AB-2103/2104 frequency counters are single function counters only for measurement of frequency. The basic composition consists of an input circuit, reference signal generator section, timing pulse generating section, counting logic section, display section, and power source, as shown in Fig. below.



Basic configuration of AB-2103/2104 frequency counters

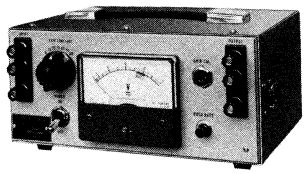
TYPES AB-2103/2104, FREQUENCY COUNTERS

SPECIFICATIONS

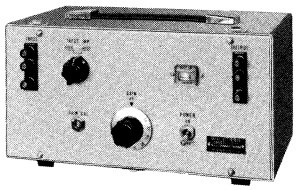
Type			AB-2103	AB-2104
Frequency range			10Hz to 550MHz	10Hz to 1000MHz
Signal input	Input 1	Range	10Hz to 60MHz	
		Sensitivity	50mVrms, 10Hz to 30Hz 20mVrms, 30Hz to 30MHz 50mVrms, 30MHz to 60MHz	
		Input attenuator	1, 1/10	
		Input impedance	1MΩ or more, 40pF or less	
		Resolution	0.1Hz, 1Hz, 10Hz	
		Gate time	10s, 1s, 0.1s	
		Measurement unit	kHz and MHz with positioned decimal point	
	Input 2	Range	50MHz to 550MHz	50MHz to 1000MHz
		Sensitivity	20mVrms, 50MHz to 400MHz 50mVrms, 400MHz to 1000MHz (AB-2103, up to 550MHz)	
		Maximum input	500mVrms	400mVrms
		Input impedance	50Ω; VSWR, 1.8 or less	50Ω; VSWR, 2.0 or less
		Resolution	1Hz, 10Hz, 100Hz	
		Gate time	10s, 1s, 0.1s	
		Measurement unit	MHz with positioned decimal point	
		Damage level	2Vrms	
Accuracy			±1 count ± time base accuracy	
Display			9 digits; 7 segments LED display, 0-surpress	
Crystal oscillator stability		Temperature (0 to 40°C)	$\pm 1 \times 10^{-7}$	$\pm 5 \times 10^{-8}$
		Aging rate	1×10^{-7}/month	8×10^{-8}/month
			Typical after 24 hours warm-up	
		Warm-up	$\pm 1 \times 10^{-7}$	$\pm 5 \times 10^{-8}$
			In 10 minutes (1 hour warm-up reference)	
Power requirements			90–120V AC or 180–240V AC (switch selection at the rear panel)	
Dimensions			Approx. 100(H) x 280(W) x 150(D)mm	
Weight			Approx. 3.5kg	
Other description			The oven oscillator becomes ready for operation after connecting the plug into the power-line receptacle	

5 AUXILIARY MEASURING SETS
(Amplifiers, Attenuators, Filters, & Switching Units)

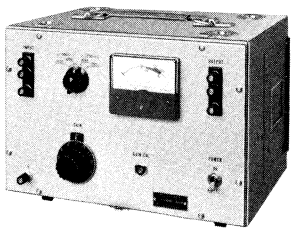
AMPLIFIERS
TYPES TA-2A/18/15B/21



TYPE TA-2A



TYPE TA-18



TYPE TA-15B

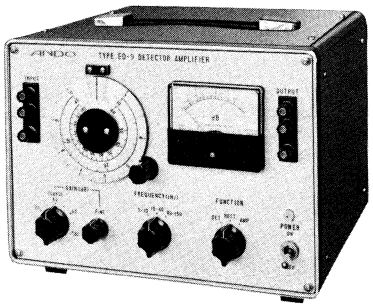
TYPE TA-21

SPECIFICATIONS

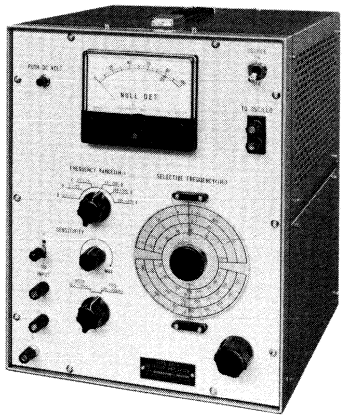
Instrument	TA-2A Amplifier	TA-18 Amplifier	TA-15B Amplifier	TA-21 Amplifier
Frequency range	1 kHz	30 Hz to 10 kHz	3 to 150 kHz	10 kHz to 50 MHz
Gain	0 to 60 dB in 1 dB steps	15 to 60 dB in 5 dB steps	15 to 60 dB in 5 dB steps	0 to 30 dB in 5 dB steps
Frequency response	———	±0.5 dB (1 kHz reference)	Deviation, 1 dB or less	At 0 dB gain ±0.2 dB, 10 kHz to 17 MHz ±0.5 dB, 10 kHz to 30 MHz ±1 dB, 10 kHz to 50 MHz
Input impedance	600Ω balanced	600Ω/high, balanced	75Ω/high, balanced 600Ω/high, balanced	75Ω unbalanced
Output impedance	600Ω balanced	600Ω balanced	600Ω and 75Ω balanced	75Ω unbalanced
Maximum output	0 dBm	+15 dBm	+10 dBm	+10 dBm, 10 kHz to 30 MHz +5 dBm, 30 to 50 MHz
Distortion	30 dB or more at 0 dBm	30 dB or more at 0.2 kHz	40 dB or more	45 dB or more at +10 dBm
Noise (referred to input)	-90 dBm or less	-105 dBm or less	-90 dBm or less	-80 dBm or less
Power requirements	12V DC (internal) Either internal (12V) or external DC (+12V)	Either 100V AC, 50/60 Hz or -21V DC (external)	Either 100V AC, 50/60 Hz or 24V DC (internal)	Either 100V AC, 50/60 Hz or +36V DC (external)
Dimensions (HxWxD)	Approx. 95 x 210 x 165 mm	Approx. 150 x 300 x 200 mm (with front panel cover)	Approx. 200 x 300 x 250 mm (with front panel cover)	Approx. 110 x 400 x 200 mm (with front panel cover)
Weight	Approx. 3 kg	Approx. 7 kg	Approx. 10 kg	Approx. 5 kg

DETECTOR-AMPLIFIERS

TYPES ED-9/ED-7



TYPE ED-9



TYPE ED-7

In the output measurement in communication lines, level meters, selective level meters and standard level calibration sets are generally employed, but in the measurements by the zero method or comparison method detector-amplifiers which have high sensitivity in voltage detection are widely used.

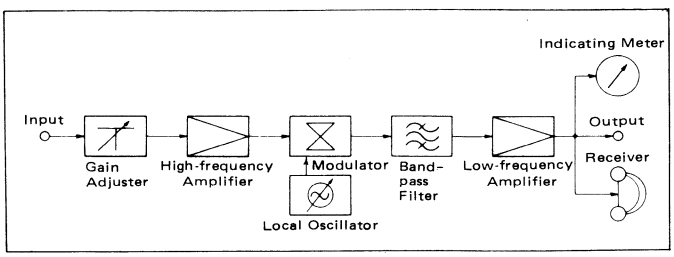
The main application area of the detector-amplifier is the detection of a specific frequency component in minute voltage signal in the measurement of transmission circuit return loss, crosstalk and impedance. Another important use is in the detection of the balance of AC bridges for measuring constants like R, C and L.

Principle of Operation

The input signal is amplified to a certain level through an attenuator for detector gain adjustment. This signal and local oscillator output signal are modulated and the low-frequency component is filtered by a band pass filter and amplified by a low-frequency amplifier to obtain the detection output.

From Ando are available two types of detector-amplifier: Type ED-9 that operates over a frequency range of 200 Hz to 150 kHz and Type ED-7 that covers a wider frequency range of 200 Hz to 1.2 MHz.

The selective level meter performs a similar function to the detector-amplifier. Ando also supplies selective level meter-generators which combine the functions of an oscillator and a selective level meter in order to make synchronous measurements.



SPECIFICATIONS

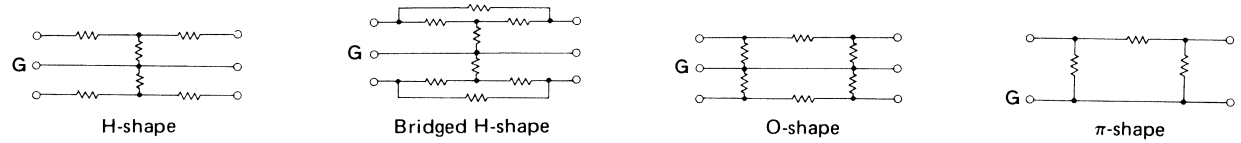
Instrument	ED-9 Detector-amplifier			ED-7 Detector-amplifier	
Function	Meter detection	Headphone detection	Amplification	Meter detection	Oscilloscope output
Input frequency	0.2 to 150 kHz	3 to 150 kHz	0.2 to 150 kHz	0.2 kHz to 1.2 MHz in six ranges	
Sensitivity or gain	−80 dB sensitivity	−85 dB sensitivity	80 dB gain	95 dB gain (no load)	
Output frequency	1 kHz (headphone detection) 0.2 to 150 kHz (amplification)			0.2 to 20 kHz for 0.2 to 20 kHz 13 kHz for 20 kHz to 1.2 MHz	
Input impedance	600Ω balanced			600Ω balanced for 0.2 to 150 kHz 75Ω balanced for 0.1 to 1.2 MHz	
Output impedance	————	600Ω balanced		————	High
Dimensions	Approx. 200(H) x 280(W) x 250(D) mm			Approx. 320(H) x 250(W) x 260(D) mm	
Weight	Approx. 8 kg			Approx. 11 kg	

VARIABLE ATTENUATORS

An attenuator is designed to decrease the magnitude of voltage, current or power without distorting it. The attenuator has a resistance circuit and is used as a practical standard of attenuation in comparative measurements of gains, losses, etc. in filters, amplifiers and various communication circuits. It is used for controlling oscillator (or signal generator) output levels, level meter input levels, etc. as well.

Connecting forms of an attenuator circuit are available in two types, a balanced type whose two sides are symmetrical with respect to ground and an unbalanced type whose two sides are inherently unlike. The balanced type uses a circuit of H-shape, bridged H-shape, or O-shape. The unbalanced type uses a circuit of π-shape. Ando offers a wide variety of variable attenuators in the frequency range from audio to UHF. Ando's attenuators are manufactured in due consideration of the following items:

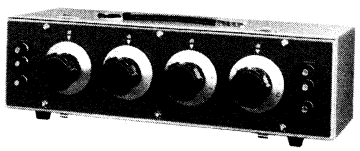
1. Accurate and stable attenuation
2. Less phase shift
3. Input/output impedances formed with pure resistance
4. Wide attenuation range in smaller steps



H-shape　Bridged H-shape　O-shape　π-shape

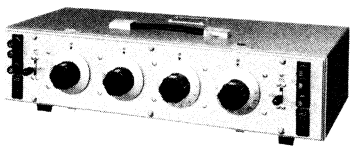
Connecting form examples

VARIABLE ATTENUATORS, DC–150kHz/700kHz



TYPE AL-205

TYPE AL-255



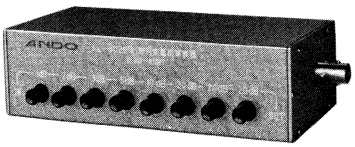
TYPE AL-352

Instrument		AL-205 Decade Attenuator	AL-255 Decade Attenuator	AL-352 Decade Attenuator
Frequency range		DC to 150kHz		600Ω: DC to 150kHz 75Ω: DC to 700kHz
Characteristic impedance		600Ω unbalanced	600Ω balanced (300 and 150Ω unbalanced circuits can be formed)*	600/75Ω, balanced (300 and 150Ω unbalanced circuits can be formed)*
Connector type		I-214	I-214	I-214, C2-11GJ
Connecting form		π-shape	Bridged H-shape, O-shape	600Ω: Bridged H-shape 75Ω: Bridged H-shape, O-shape
Attenuation	Range	0 to 121 dB		0 to 91dB
	Step	0.1dB x 10, 1dB x 10 10dB x 5, 60dB x 1		0.1dB x 10, 1dB x 10 10dB x 5, 30dB x 1
	Accuracy	0 to 50kHz: ±0.2dB, 0 to 90dB ±0.5dB, 90 to 121dB 0 to 150kHz: ±0.5dB, 0 to 90dB ±1dB, 90 to 121dB	±0.1dB, 0 to 5dB ±0.2dB, 0 to 40dB ±0.5dB, 0 to 121dB	Step accuracy (1kHz, 0 to 91dB): ±0.2dB Frequency response: ±0.3dB
Maximum input level		+27dBm	+30dBm	+30dBm
Capacitance unbalance		———	20 pF or less at 1kHz	600Ω: 20pF or less at 3kHz 75Ω: 30pF or less at 10kHz
Dimensions (H x W x D)		Approx. 100 x 350 x 150mm (with front cover)		Approx. 100 x 420 x 220mm (with front cover)
Weight		Approx. 3.5kg		Approx. 5kg

* The specifications do not apply to the 300Ω and the 150Ω unbalanced circuits.

VARIABLE ATTENUATORS, DC–50/250MHz

TYPE AL-401

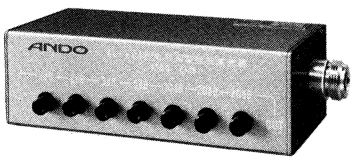


TYPE AL-502B-B

TYPE AL-511SP

Instrument	Type	AL-401	AL-501B-⌜ ⌟	AL-502B-⌜ ⌟	AL-511SP	AL-512N
	Name	Decade Attenuator	VHF Attenuator		VHF Attenuator	
Frequency range		DC to 50MHz	DC to 250MHz		DC to 250MHz	
Characteristic impedance		75Ω unbalanced	75Ω unbalanced	50Ω unbalanced	75Ω unbalanced	50Ω unbalanced
Connector type		BNC	M BNC	N BNC	SP	N
Connecting form		π-shape	π-shape		π-shape	
Return loss		30dB or more, DC to 17MHz 20dB or more, 17 to 50 MHz	15dB or more		30dB or more	
Attenuation	Range	0 to 91dB	0 to 81dB		0 to 91dB	
	Step	0.1dB x 10, 1dB x 10 10dB x 5, 30dB x 1	1, 2, 3, 5, 10, 20, 20, 20dB Eight push buttons		0.1dB x 10, 1dB x 10 10dB x 8	
	Accuracy	Step accuracy (1kHz) ±0.05dB, 0 to 1dB ±0.1dB, 0 to 11 dB ±0.2dB, 0 to 91dB Frequency response ±0.3dB, each step	±0.5dB, DC to 100MHz ±1.0dB, DC to 250MHz		±0.2dB, DC to 100MHz ±0.3dB, DC to 250MHz	
Insertion loss		————	0.5dB or less, DC to 100MHz 1.0dB or less, DC to 250MHz		0.3dB or less, DC to 100MHz 0.4dB or less, DC to 250MHz	
Maximum input level		+24dBm	+20dBm		+20dBm	
Dimensions (H x W x D)		Approx. 80 x 320 x 135mm (with front cover)	Approx. 40 x 140 x 60mm		Approx. 100 x 210 x 100mm	
Weight		Approx. 3kg	Approx. 0.6kg		Approx. 4kg	

VARIABLE ATTENUATORS, DC–1000MHz



TYPE AL-604B-N

TYPE AL-611SP

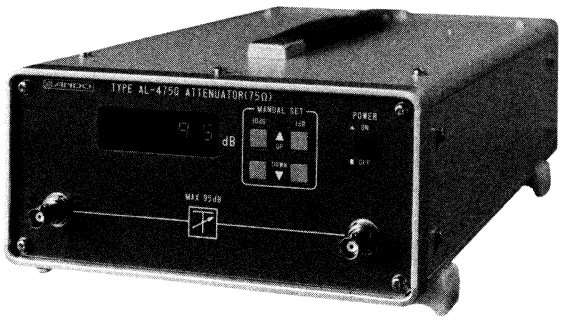
Instrument	Type	AL-604B-N	AL-604B-B	AL-611SP
	Name	UHF Attenuator		UHF Attenuator
Frequency range		DC to 1000MHz		DC to 1000MHz
Characteristic impedance		50Ω unbalanced		75Ω unbalanced
Connector type		N	BNC	SP
Connecting form		π-shape		π-shape
Return loss		15dB or more		25dB or more
Attenuation	Range	0 to 61dB		0 to 81dB
	Step	1, 2, 3, 5, 10, 20, 20dB Seven push buttons		0.1dB x 10, 1dB x 10 10dB x 7
	Accuracy	±1.0dB		±0.2dB, DC to 600MHz ±0.3dB, DC to 1000MHz
Insertion loss		1dB or less, DC to 500MHz 2dB or less, DC to 1000MHz		1dB or less
Maximum input level		+21dBm		+20dBm
Dimensions (H x W x D)		Approx. 40 x 122 x 60mm		Approx. 100x 210 x 100mm
Weight		Approx. 0.6kg		Approx. 3kg

ATTENUATORS (Programmable)
TYPES AL-4550/4551/4750

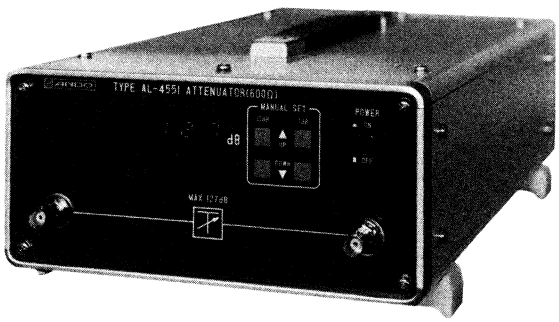
GP-IB

- *Ideal for complete system use*
- *DC-200kHz/500kHz/30MHz*
- *Accurate, fast remote setting of any desired signal level*
- *GP-IB or BCD remote control capability*

TYPE AL-4550



TYPE AL-4750



TYPE AL-4551

The programmable attenuators of this series, complementary units of automatic measurement systems, are intended for use in accurate, fast remote setting of signal levels over a frequency range from voice band to HF band.

USES

- The operation of automatic measuring instruments, such as frequency synthesizer and level meter, is greatly facilitated by these programmable attenuators for instance, in applications where comparative measurements of attenuation are to be made.
- Find use as automatic level adjusters for communications systems.
- Find use as automatic level adjusters in production lines of TV, radio and VTR.
- Serve as automatic input level adjusters in the measurement of filter and analog IC characteristics.

FEATURES

- High stability and reproducibility. Attenuation is variable in 1 dB steps.
- Attenuation is indicated digitally.
- Excellent impedance matching.
- Controllable by the GP-IB or BCD.
- Can be operated manually.

TYPES AL-4550/4551/4750, ATTENUATORS

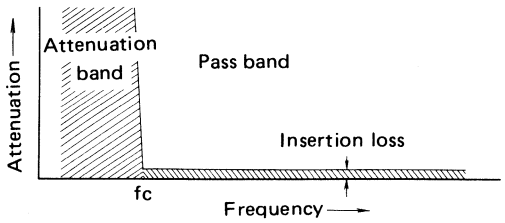
SPECIFICATIONS

Type		AL-4550	AL-4551	AL-4750
Frequency range		DC to 200 kHz	DC to 500 kHz	DC to 30 MHz
Impedance		600 Ω balanced	600 Ω unbalanced	75 Ω unbalanced
Circuit type		O type	π type	
Connector		I-214	BNC	BNC
Return loss		30 dB or more	30 dB or more (DC to 200 kHz) 25 dB or more (DC to 500 kHz)	30 dB or more (DC to 20 MHz) 25 dB or more (DC to 30 MHz)
Attenuation	Range	0 to 127 dB		0 to 95 dB
	Step	1 dB		
	Accuracy	DC accuracy: Within ±0.015 dB (1, 2, 4, 8 dB) Within ±0.03 dB (16, 32, 64 dB) Frequency response: Within ±0.05 dB (0 to 30 dB) Within ±0.1 dB (0 to 60 dB) Within ±0.15 dB (0 to 127 dB)		
Insertion loss (at 0 dB)		0.1 dB or less		$(0.2 + 0.1\sqrt{f})$ dB; f = MHz
Maximum input level		+20 dBm		+17 dBm
Switching speed and life		20 ms or less and 1 000 000-step switchings or more		
Setting		Manual and external control (GP-IB or BCD)		
Power requirements		100 V AC, 50/60 Hz, 20 VA or less		
Dimensions		Approx. 100 (H) x 200 (W) x 350 (D) mm		
Weight		Approx. 5 kg		
Options		GP-IB connecting cable, BCD connecting cable, connection accessories, measuring cable (coaxial, balanced)		

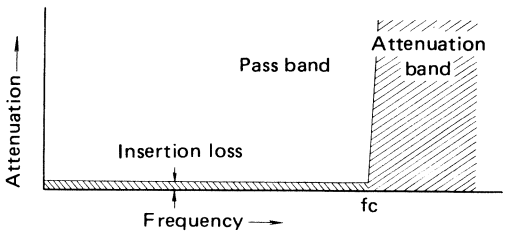
VARIABLE FILTERS

A filter is a four-terminal network consisting of R, L and C. The filter allows waves (electric current and voltage) of some specified frequency band (pass band) to pass, and does not allow those of other frequency bands (attenuation bands) to flow.
A frequency at the transition between the pass band and the attenuation band is called cut-off frequency (fc).
Filters in this section of the catalog are high pass filters and low pass filters.
The high pass filters have the pass band from cut-off frequency (not zero) up to infinite frequency. The low pass filter have the pass band from zero frequency up to some cut-off frequency which is not infinite.
Ando's filters are manufactured in due consideration of the following items:

1. Smaller loss in the pass band; larger loss in the attenuation band
2. The flatness of level in the pass band
3. Stable characteristic impedance in the operating frequency range
4. Sharp cut-off
5. Long-term trouble-free life

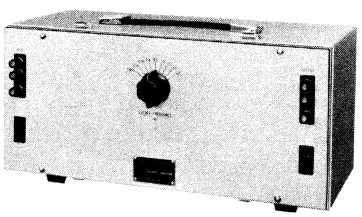


Variable high pass filter

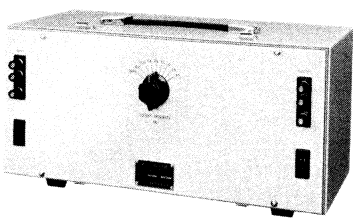


Variable low pass filter

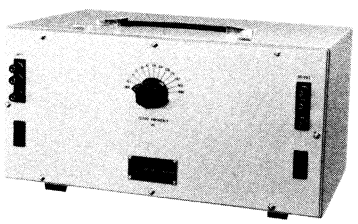
VARIABLE HIGH PASS FILTERS



TYPE HF-11



TYPE HF-12

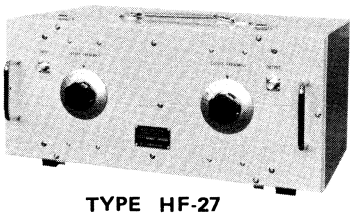


TYPE HF-13

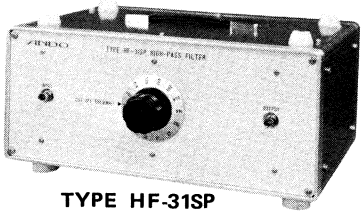
Type	HF-11	HF-12	HF-13
Frequency range	150 Hz to 12 kHz	4 to 200 kHz	10 to 700 kHz
Cut-off frequency	0.15-0.25-0.4-0.6-1-1.5-2.5-4 kHz (8 frequencies)	4-6-9-13-20-30-45-68 kHz (8 frequencies)	10.7-15-21-30-42-60-84-120-170-240-340-480 kHz (12 frequencies)
Characteristic impedance	600Ω balanced	600Ω balanced	75Ω balanced
Input/output terminals	Type I-214 and C2-11GJ		
Attenuation	45 dB or more: 1/1.4 fc to 1/3 fc 5 dB or less: 1 fc to 12 kHz	45 dB or more: 1/1.4 fc to 1/3 fc 5 dB or less: 1 fc to 200 kHz	45 dB or more: 1/1.4 fc to 1/3 fc 5 dB or less: 1 fc to 700 kHz
Max. input level	+20 dBm		
Dimensions (H x W x D)*	Approx. 180 x 390 x 210 mm	Approx. 180 x 390 x 210 mm	Approx. 190 x 390 x 245 mm
Weight	Approx. 11 kg	Approx. 12 kg	Approx. 12 kg

* including front panel cover.

VARIABLE FILTERS



TYPE HF-27

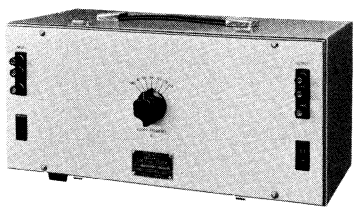


TYPE HF-31SP

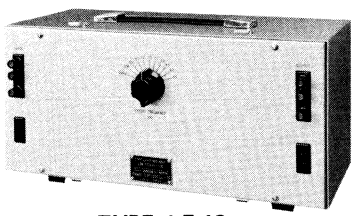
Type	HF-27	HF-32	HF-31SP
Frequency range	50 kHz to 30 MHz	1 to 120 MHz	18 to 3450 MHz
Cut-off frequency	70–100–140–200– 280–400 kHz 0.56–0.8–1.2–1.6–2.4 –3.2–4.8–6.4–9.6– 12.8 MHz (16 frequencies)	2.5–3.5–5–7.5–10– 15–21–30–42–62– –84 MHz (11 frequencies)	18–25–36–51–72– 102–144–204–288– 407–576–814–1150 MHz (13 frequencies)
Characteristic impedance	75Ω unbalanced	75Ω unbalanced	75Ω unbalanced
Input/output terminals	BNC	SP	SP
Attenuation	45 dB or more: 1/1.4fc to 1/3fc 5 dB or less: 1fc to 30 MHz	45 dB or more: DC to 1/1.4fc 5 dB or less: 1fc to 62 MHz (fc ≦ 10 MHz) 5 dB or less: 1 fc to 120 MHz (fc ≦ 15 to 84 MHz)	40 dB or more: 1/1.4fc to 1/3fc
Max. input level	+15 dBm	+15 dBm	+20 dBm
Dimensions (HxWxD) mm	Approx. 200x450x270*	Approx. 100x350x250*	Approx. 100x350x200
Weight	Approx. 12 kg	Approx. 6 kg	Approx. 9 kg

* including front panel cover

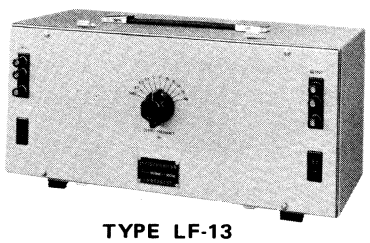
VARIABLE LOW PASS FILTERS



TYPE LF-11



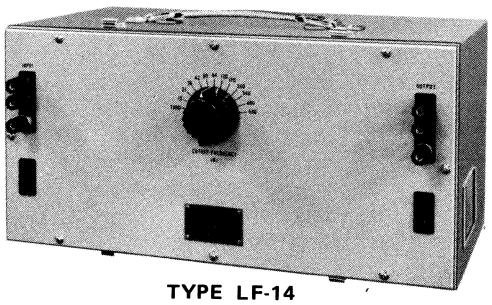
TYPE LF-12



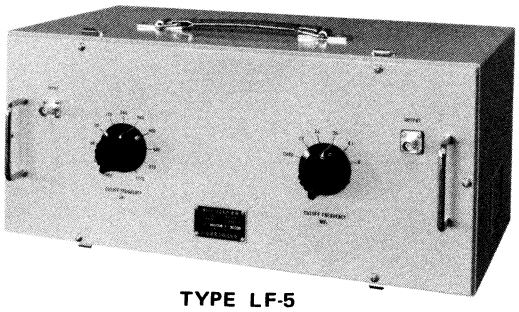
TYPE LF-13

Type	LF-11	LF-12	LF-13
Frequency range	30 to 250 Hz	250 Hz to 8.5 kHz	3 to 100 kHz
Cut-off frequency	42-60-85-120-170-250 Hz (6 frequencies)	0.35-0.5-0.7-1.0-1.5-2.1- 3.0-4.2-6.0-8.5 kHz (10 frequencies)	4.2-6-8.5-12-17-25-35-50-70- 100 kHz (10 frequencies)
Characteristic impedance	600Ω balanced		
Input/output terminals	Types I-214 and C2-11GJ		
Attenuation	45 dB or more: 1.4 fc to 3 fc (40 dB or less at fc = 100 Hz or less) 5 dB or less: 30 Hz to 1 fc (8 dB or less at fc = 100 Hz or less)	45 dB or more: 1.4 fc to 3 fc 5 dB or less: 0.25 kHz to 1 fc	45 dB or more: 1.4 fc to 3 fc 5 dB or less: 3 kHz to 1 fc
Max. input level	+20 dBm		
Dimensions (H x W x D)	Approx. 180 x 390 x 210 mm (with front cover)		
Weight	Approx. 9 kg	Approx. 10 kg	Approx. 10 kg

VARIABLE FILTERS

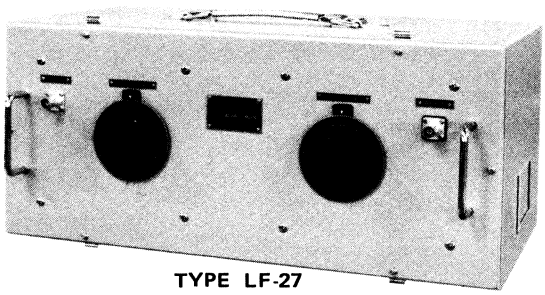


TYPE LF-14

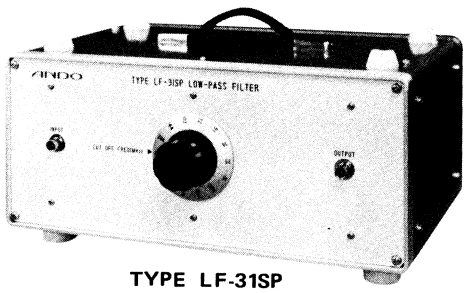


TYPE LF-5

Type	LF-14	LF-5
Frequency range	10 to 700 kHz	50 kHz to 6 MHz
Cut-off frequency	15-21-30-42-60-84-120-170-240-340-480-680 kHz (12 frequencies)	60-84-120-170-240-340-480-680-970-1370-1900-2600-3600-4100-6000 kHz (15 frequencies)
Characteristic impedance	75Ω balanced	75Ω unbalanced
Input/output terminal	Types I-214 and C2-11GJ	Type BNC
Attenuation	45 dB or more: 1.4 fc to 3 fc 5 dB or less: 10 kHz to 1 fc	45 dB or more: 1.4 fc to 3 fc 5 dB or less: 50 kHz to 1 fc
Max. input level	+20 dBm	+20 dBm
Dimensions (H x W x D)	Approx. 190 x 390 x 245 mm (with front cover)	Approx. 200 x 450 x 275 mm (with front cover)
Weight	Approx. 12 kg	Approx. 16 kg



TYPE LF-27



TYPE LF-31SP

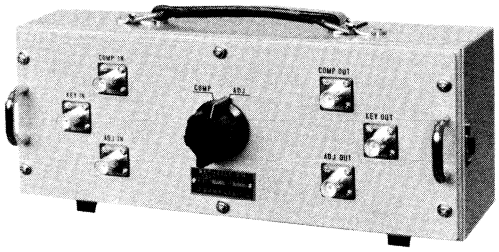
Type	LF-27	LF-32	LF-31SP
Frequency range	200 kHz to 30 MHz	1 to 120 MHz	DC to 3450 MHz
Cut-off frequency	0.28–0.4–0.56–0.8–1.2–1.6–2.4–3.2–4.8–6.4–9.6–12.8–19.2 MHz (13 frequencies)	3.5–5–7.5–10–15–21–30–42–62–84–120 MHz (11 frequencies)	18–25–36–51–72–102–144–204–288–407–576–814–1156 MHz (13 frequencies)
Characteristic impedance	75Ω	75Ω	75Ω
Input/output terminals	BNC	SP	SP
Attenuation	45 dB or more: 1.4fc to 3fc 5 dB or less: within pass handwidth	45 dB or more: 1.4fc to 5fc (5fc ≦ 200MHz) 5 dB or less: 1MHz to 1fc	40 dB or more: 1.4fc to 3fc
Max. input level	+15 dBm	+15 dBm	+20 dBm
Dimensions (HxWxD) mm	Approx. 200x 450x270*	Approx. 100x350x250*	Approx. 100x350x200
Weight	Approx. 13 kg	Approx. 6.5 kg	Approx. 9 kg

* including front panel cover

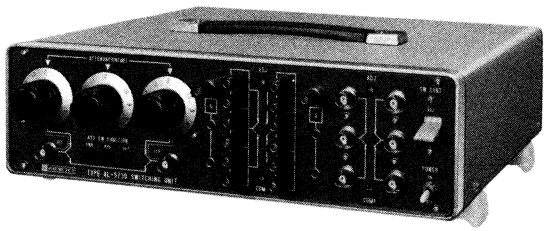
SWITCHING UNITS

TYPES SH-1B/SC-2B/AL-5730/SC-11SP

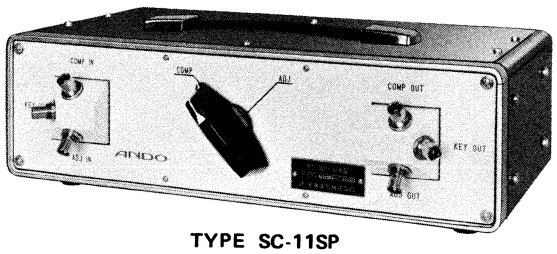
TYPE SH-1B



TYPE SC-2B



TYPE AL-5730



TYPE SC-11SP

SPECIFICATIONS

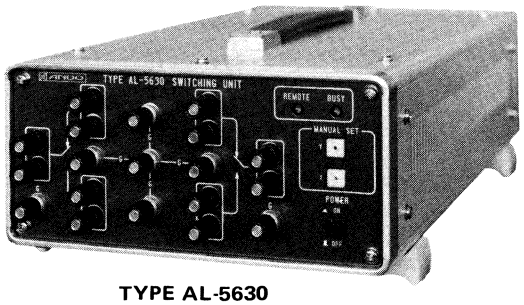
Type	SH-1B	SC-2B	AL-5730*	SC-11SP
Frequency range	DC to 150 kHz	DC to 30 MHz	DC to 30 MHz	DC to 1000 MHz
Use	For carrier system	For coaxial system	For coaxial system	For coaxial system
Crosstalk attenuation	Across contact points: more than 60 dB Across circuits: more than 120 dB	Across contact points: more than 45 dB (up to 17MHz); more than 40 dB (up to 30 MHz) Across circuits: more than 85 dB	**Across contact points: more than 60 dB** **Across circuit: more than 100 dB; more than 85 dB (more than 100 kHz, balanced)**	Across contact points: more than 60 dB Across circuits: more than 120 dB
Impedance	600Ω balanced	75Ω unbalanced	600Ω balanced, DC to 150 kHz 150Ω balanced, DC to 700 kHz 75Ω balanced, DC to 700 kHz 75Ω unbalanced, DC to 30 MHz	75Ω unbalanced
Connectors	I-214	BNC	I-214 and BNC	SP
Return loss	———	More than 30 dB	More than 35 dB	More than 25 dB
Dimensions (HxWxD)	Approx. 110x280x120 mm	Approx. 110x280x120 mm	Approx. 100x350x250 mm	Approx. 100x350x200 mm
Weight	Approx. 2 kg	Approx. 2 kg	Approx. 3.8 kg	Approx. 5.5 kg

* The AL-5730 has an attenuator section (attenuation 0 to 91 dB in 0.1 dB steps).
The AL-5730 also functions as a component unit of Type AH-4730D Transmission Measuring Test Set (see page 114), when used with Ando's Type AJ-2730 Frequency Synthesizer (see page 20) and Type AD-4730 Level Meter (see page 42).

SWITCHING UNITS
TYPES AL-5530/5630/5731

GP-IB

● *Programmable switching units for system use*



TYPE AL-5630

TYPE AL-5731

The switching units of this series, being designed as complementary units of automatic measurement systems, switch signals as programmed over the frequency range of voice band to HF band.

USES

- The operation of automatic measurement instruments, such as frequency synthesizer and level meter, is greatly facilitated by these switching units, for instance, in applications where comparative measurements of attenuation are to be made.
- These switching units provide for high-efficiency remote setting of monitoring or control systems.

FEATURES

- Fast switching speed
- Low crosstalk
- Excellent impedance matching
- GP-IB or BCD remote control capability
- Can be operated manually

SPECIFICATIONS

Type number	AL-5530	AL-5630	AL-5731
Frequency range	DC to 500 kHz	DC to 1 MHz	DC to 30 MHz
Impedance	600 Ω unbalanced	75/150 Ω balanced (DC to 1 MHz) 600 Ω balanced (DC to 200 kHz)	75 Ω unbalanced
Connector	BNC	I-214	BNC
Return loss	30 dB or more (DC to 200 kHz) 25 dB or more (DC to 500 kHz)	30 dB or more	30 dB or more (DC to 10 MHz) 25 dB or more (DC to 30 MHz)
Crosstalk attenuation	100 dB or more (DC to 200 kHz) 85 dB or more (200 to 500 kHz)	100 dB or more across circuits 60 dB or more across contacts	100 dB or more (DC to 10 MHz) 85 dB or more (10 to 30 MHz)
Insertion loss	0.05 dB or less		0.1 dB or less
Switching method	Manual and external control (GP-IB and TTL levels)		
Switching speed and life	20 ms or less and 1 000 000 switchings or more		
Maximum input level	+20 dBm (DC 100 mA or less)		
Power requirements	100 V AC, 50/60 Hz, 20 VA or less		
Dimensions	Approx. 100 (H) x 210 (W) x 350 (D) mm		
Weight	Approx. 5 kg		
Options	GP-IB cable, BCD cable, connection accessories, measuring cable (coaxial, balanced)		

CHANNEL SELECTORS

TYPES AL-5570/5571/5770/5771

GP-IB

- *Designed for automatic measurement system use*
- *DC-200kHz/30MHz*
- *Can switch signals of up to 100 channels*
- *GP-IB remote control*

TYPE AL-5571

TYPE AL-5570

TYPE AL-5771

TYPE AL-5770

The channel selectors of this series, being designed as complementary units of automatic measurement systems, provide accurate, fast switching of multi-channel signals over a range of DC to 30 MHz, thus significantly reducing down-time in measurement.

USES

- The operation of automatic measurement instruments, such as frequency synthesizer and level meter, is greatly facilitated by these channel selectors, for instance, in applications where multi-channel signlas are to be scanned with a minimum of down-time in switching.
- These channel selectors find use in the maintenance of FDM communications systems, in monitoring various base band signals (e.g., pilot signals, channel levels, noise) and in switching signals in production lines.
- If used together with a desktop computer, these channel selectors provide for statistical processing of data from various sources.

FEATURES

- Low crosstalk (85 dB or more)
- Stable and reliable
- Expandable up to 100 channels
  (One master channel selector accepts 10 slaves.)
- One master channel selector can control slaves with different impedances.

TYPES AL-5570/5571/5770/5771, CHANNEL SELECTORS

SPECIFICATIONS

Type number	AL-5570	AL-5571	AL-5770	AL-5771
Frequency range	DC to 200 kHz		DC to 30 MHz	
Impedance	600 Ω balanced (Unnecessary channels are terminated with 600 Ω resistors.)		75 Ω unbalanced	
Connector	I-214		BNC	
Return loss	30 dB or more		Selected channel 30 dB or more (DC to 10 MHz) 25 dB or more (10 to 30 MHz)	
Crosstalk attenuation	85 dB or more		85 dB or more	
Insertion loss	0.1 dB or less		0.15 dB or less (DC to 10 MHz) 0.3 dB or less (10 to 30 MHz)	
Number of channels selectable	10 maximum			
Switching method	AL-5570/5770: Manual and external control (GP-IB) AL-5571/5771: Controlled by AL-5570/-5770			
Switching speed and life	20 ms or less and 1 000 000 switching or more			
Maximum input level	+20 dBm (DC 100 mA or less)			
Power requirements	100 V AC, 50/60 Hz; approx. 20 VA or less			
Dimensions (H x W x D)	Approx. 150 x 425 x 350 mm	Approx. 100 x 425 x 350 mm	Approx. 150 x 425 x 350 mm	Approx. 100 x 425 x 350 mm
Weight	Approx. 8.5 kg	Approx. 6.5 kg	Approx. 9.5 kg	Approx. 7.5 kg
Accessories supplied	————	One connecting cable	————	One connecting cable
Options	GP-IB cable, measuring cable (coaxial, balanced)			

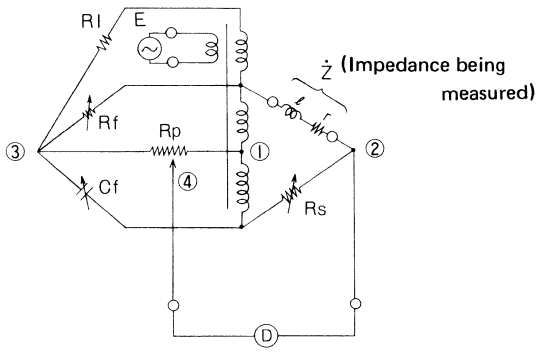
6 IMPEDANCE/RETURN LOSS MEASURING SETS

GENERAL INFORMATION

IMPEDANCE MEASUREMENT

The impedance bridge provides for direct reading of the absolute value of impedance and phase angle of communication equipment and transmission lines.

The impedance bridge is a combination of Toulon's phase circuit and a suitable type of compensation circuit. One branch of the bridge reads the absolute value of impedance and the phase compensation circuit reads the phase angle.



Principle of Operation
(Example of Measurement of Inductive Impedance)

Rs:	This bridge is balanced when $\|\dot{Z}\|$ = Rs (the absolute value of impedance equals Rs).
Rp:	Voltage divider having a phase angle scale
Cf, Rf:	Phase circuits that correspond to the measuring frequencies
RI:	Phase compensation resistor

When such an adjustment is made in this bridge that Rs equals $|\dot{Z}|$ a voltage that corresponds to the phase angle of $\dot{Z}$ occurs across ① and ②. This voltage has the phase difference with the power supply (E) by 90°.

RI, Rf, Rp and Cf are phase circuits and voltage dividers which are used to generate a voltage at ④ which is in inverse phase with and in equal amplitude to the voltage across ① and ②.

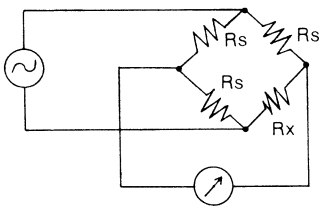
The impedance measurement by this bridge is started by selecting the phase circuits (Rf and Cf), followed by the adjustment of Rp and Rs to minimize the output of detector D. When the voltage across ① and ② is offset by that across ① and ④. the bridge comes into balanced state so that the absolute value of impedance can be read from Rs and the phase angle from Rp.

RETURN LOSS MEASUREMENT

The return loss measuring set is used in the measurement of input and output impedances of transmission circuits and equipment.

Return loss measurement is made through the use of a combination of an oscillator and a level meter. Return loss is expressed by the reciprocal of reflection that occurs when the impedance being measured differs from the reference impedance.

The principle of operation consists in the detection of unbalance by the bridge made up of three Rs branches assigned to reference impedance and one Rf branch assigned to impedance to be tested.



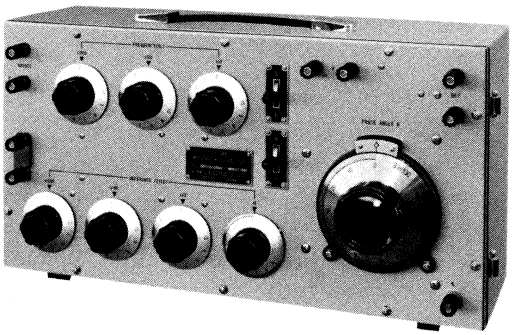
Let return loss be α, and it can be calculated as follows:

$$\alpha = 20 \log \left| \frac{Rs + Rx}{Rs - Rx} \right| dB$$

DIRECT READING IMPEDANCE BRIDGES

TYPES DRZ-1/2M/3/4

These are direct reading impedance bridges. Each bridge is a combination of a CR phase bridge and an impedance bridge device for conveniently measuring an absolute impedance value and phase angle.

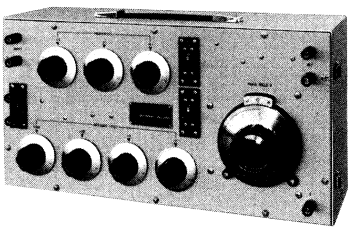


TYPE DRZ-1 (0.2–5kHz)

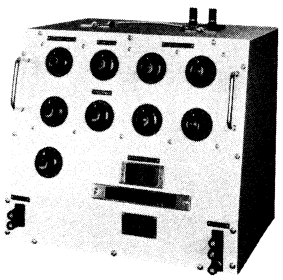
FEATURES

- Easy to use; small and compact.
- Since dials are graduated in a uniform scale, direct readings of measured values can be easily made.
- Usable for both balanced and unbalanced circuits.

TYPE DRZ-2M (0.2–100kHz)



TYPE DRZ-3 (3–150kHz)



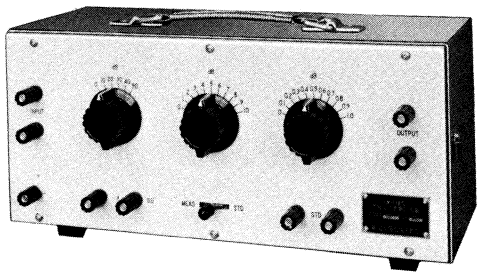
TYPE DRZ-4 (10–500kHz)

SPECIFICATIONS

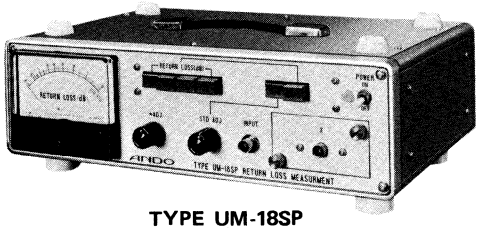
Type	DRZ-1	DRZ-2M	DRZ-3	DRZ-4
Frequency range	200 Hz to 5 kHz	200 Hz to 100 kHz	3 to 150 kHz	10 to 500 kHz
Measuring range	Z: 10 to 10000Ω; ∠ ϕ: 0 to ± 90°			Z: 10 to 1000Ω; ∠ ϕ: 0 to ± 90°
Resolution	Z: 0.1Ω; ∠ϕ: 0.5°			
Accuracy*	(At 50 to 3000Ω balanced circuit) Z: ± (1% + 0.1Ω) ∠ϕ: ± 0.5°	(0.2 to 70kHz; at 50 to 3000Ω balanced circuit) Z: ± (1% + 0.2Ω) ∠ϕ: ± [A·f·z**(%) + 0.5°]	(At 50 to 3000Ω balanced circuit) Z: ± (1% + 0.1Ω) ∠ϕ: ± [A·f·z** (%) + 0.5°]	(At 10 to 1000Ω balanced circuit) Z: ± (2% + 1Ω) ∠ϕ: ± 2°
Dimensions	Approx. 230 (H) x 440 (W) x 180 (D) mm (with front panel cover)			Approx. 300 (H) x 340 (W) x 250 (D) mm
Weight	Approx. 8.6 kg	Approx. 8.6 kg	Approx. 7 kg	Approx. 8.6 kg
Remarks	(1)* : Accuracy is reduced in the case of unbalanced circuit (i.e., error will increase by three-times). (2)**: Where A is the proportional constant (2×10^{-2}), f is the measuring frequency (kHz) and Z is the measured impedance (kΩ). (3) : The following instruments are recommended as a signal source and detectors: Type TCO-48 Oscillator Type ED-9 Detector-amplifier (for DRZ-1, -2M, -3) Type ED-7 Detector-amplifier (for DRZ-4)			

RETURN LOSS MEASURING SETS

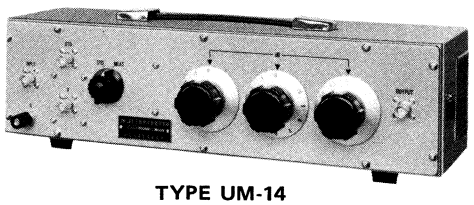
TYPES UM-11B/14/18SP



TYPE UM-11B



TYPE UM-18SP



TYPE UM-14

SPECIFICATIONS

Type number	UM-11B	UM-14	UM-18SP
Frequency range	30 Hz to 150 kHz	50 kHz to 17 MHz	1 to 1000 MHz
Line impedance	100 to 1000 Ω, balanced or unbalanced	37.5 to 150 Ω, unbalanced	75 Ω unbalanced
Measuring range	0 to 60 dB in 0.1 dB steps	0 to 51 dB in 0.2 dB steps	0 to 40 dB (0.5 dB resolution)
Measuring accuracy	(with reference to 600 Ω) ±0.5 dB from 15 to 35 dB ±1 dB from 10 to 50 dB ±1.5 dB from 0 to 60 dB	(with reference to 75 Ω) ±0.5 dB from 15 to 30 dB (300 kHz to 12.5 MHz) ±1 dB from 10 to 40 dB (50 kHz to 17 MHz)	(at measuring signal level of 0 dBm) ±1.5 dB from 15 to 30 dB ±4.5 dB from 10 to 40 dB
Maximum input level	+20 dBm	+15 dBm	+5 dBm
Power requirements	———	———	100 V AC, 50/60 Hz; approx. 4 VA
Dimensions (H x W x D)	Approx. 160 x 360 x 180 mm	Approx. 106 x 400 x 160 mm	Approx. 100 x 350 x 200 mm
Weight	Approx. 12 kg	Approx. 3.5 kg	Approx. 5 kg
Companion instruments recommended	TCO-48 Oscillator Detector having balanced high input impedance characteristics (20 kΩ or more)	AJ-2730 Frequency Synthesizer AD-4730 Level Meter	GET-42SP Oscillator

7 L, C, R COMPONENTS

INDUCTORS, CAPACITORS AND RESISTORS

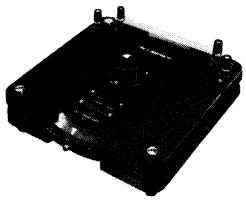
STANDARD SELF INDUCTORS

Type	Inductance	Allowable current	Accuracy (at 1kHz)	Dimensions & weight
RS-102	0.1 mH	4000 mA	± 0.25%	Approx. 200x200x200 mm Approx. 7 kg
RS-104	1 mH	2000 mA	± 0.1%	
RS-106	10 mH	650 mA	± 0.1%	
RS-108	100 mH	240 mA	± 0.1%	
RS-110	1 H	100 mA	± 0.1%	

TYPE RS-110

STANDARD VARIABLE INDUCTORS

Type	Self inductance		Mutual inductance	Remarks
	Inductance	Accuracy (at 1kHz)		
B-1	0.1 to 0.65 mH	± 5%	± 0 to 0.14 mH	Mutual inductance can be found through the use of the attached calibration chart. Dimensions: Approx. 103 x 240 x 240 mm Weight: Approx. 4.5 kg
B-2	0.6 to 4.0 mH	± 3%	± 0 to 0.8 mH	
B-3	1.5 to 10 mH	± 2%	± 0 to 2 mH	
B-4	8 to 50 mH	± 1%	± 0 to 10 mH	
B-5	15 to 100 mH	± 0.5%	± 0 to 20 mH	
B-6	80 to 420 mH	± 0.5%	± 0 to 90 mH	
B-7	150 to 1000 mH	± 0.5%	± 0 to 200 mH	
B-8	900 to 6000 mH	± 0.5%	± 0 to 1200 mH	



TYPE B-1

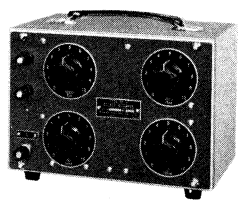
DECADE INDUCTOR (Self Inductor)

Type	Inductance range	Dials	Min. step	Accuracy (at 1 kHz)	Dimensions & weight
AM-3301	0 to 1110 mH	3 decade dials	1 mH	±(1% +0.025mH)	Approx. 100x280x155mm Approx. 2.7 kg

TYPE DSC-1

DECADE CAPACITOR

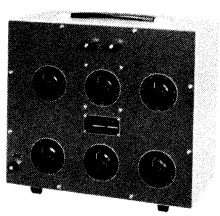
Type	Capacitance range	Dials	Min. step	Rating voltage	Dimensions & weight
DSC-1	200pF to 11.111μF	4 decade and 1 continuously variable dials	10pF	150V DC	Approx. 150x425x200 mm. Approx. 5.8 kg



TYPE AP-2

DECADE RESISTORS

Type	Resistance range (Max.)	No. of dials	Min. step	Frequency (Max.)	Accuracy at max. resistance (at DC)	Dimensions (Approx.)	Weight (Approx.)
AP-1	1111Ω	4	0.1Ω	100kHz	±0.15%	190x185x135mm	3 kg
AP-2	11110Ω	4	1 Ω	50kHz	±0.1%	130x190x110mm	3 kg
AP-3	11111.1Ω	6	0.1Ω	30kHz	±0.1%	240x350x150mm	5 kg
AP-4	111111Ω	6	0.1Ω	30kHz	±0.1%	280x315x180mm	5.5kg
500-S	11111Ω	5	0.1Ω	500kHz	±1%	160x235x200 mm	5kg



TYPE AP-4

SLIDE RHEOSTATS

Type EW Slide Rheostat (single core)

Allowable current (A)	Max. resistance (Ω)	Product ordering code	Allowable current (A)	Max. resistance (Ω)	Product ordering code	Allowable current (A)	Max. resistance (Ω)	Product ordering code
0.2	3000	01195–03100*	1.5	54	01195–04100*	5.0	4.8	01195–05100*
,,	5000	01195–03200	,,	90	01195–04200	,,	8.0	01195–05200
0.4	750	01195–03300*	2.0	30	01195–04300*	6.0	3.3	01195–05300*
,,	1250	01195–03400	,,	50	01195–04400	,,	5.5	01195–05400
0.6	330	01195–03500*	2.5	19.2	01195–04500*	8.0	1.875	01195–05500*
,,	550	01195–03600	,,	32	01195–04600	,,	3.13	01195–05600
0.8	187.5	01195–03700*	3.0	13.3	01195–04700*	10.0	1.22	01195–05700*
,,	312.5	01195–03800	,,	22.2	01195–04800	,,	2.0	01195–05800
1.2	84	01195–03900*	4.0	7.5	01195–04900*	13.0	0.7	01195–05900*
,,	140	01195–04000	,,	12.5	01195–05000	,,	1.2	01195–06000

Type GEW Slide Rheostat (single core)

Allowable current (A)	Max. resistance (Ω)	Product ordering code	Allowable current (A)	Max. resistance (Ω)	Product ordering code	Allowable current (A)	Max. resistance (Ω)	Product ordering code
0.4	3125	01195–07700	1.5	222	01195–08200	5.0	20	01195–08700
0.6	1390	01195–07800	2.0	125	01195–08300	6.0	14	01195–08800
0.8	750	01195–07900	2.5	80	01195–08400	8.0	7.5	01195–08900
1.0	500	01195–08000	3.0	56	01195–08500	10.0	5.0	01195–09000
1.2	350	01195–08100	4.0	31.3	01195–08600	13.0	3.0	01195–09100

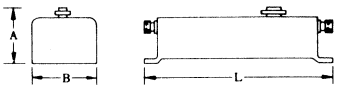
Type DW Slide Rheostat (double core)

Allowable current (A)	Max. resistance (Ω)	Product ordering code	Allowable current (A)	Max. resistance (Ω)	Product ordering code	Allowable current (A)	Max. resistance (Ω)	Product ordering code
Upper: Series connection Lower: Parallel connection			Upper: Series connecion Lower: Parallel connection			Upper: Series connection Lower: Parallel connection		
0.2	6000	01195–00100*	1.5	108	01195–01100*	5.0	9.6	01195–02100*
0.4	1500		3.0	27		10.0	2.4	
,,	10000	01195–00200	,,	180	01195–01200	,,	16.0	01195–02200
	2500			45			4.0	
0.4	1500	01195–00300*	2.0	60	01195–01300*	6.0	6.6	01195–02300*
0.8	375		4.0	15		12.0	1.65	
,,	2500	01195–00400	,,	100	01195–01400	,,	11.0	01195–02400
	625			25			2.75	
0.6	660	01195–00500*	2.5	38.4	01195–01500*	8	3.75	01195–02500*
1.2	165		5.0	9.6		16	0.94	
,,	1100	01195–00600	,,	64	01195–01600	,,	6.25	01195–02600
	275			16			1.55	
0.8	375	01195–00700*	3.0	26.6	01195–01700*	10	2.4	01195–02700*
1.6	93.6		6.0	6.7		20	0.6	
,,	625	01195–00800	,,	44	01195–01800	,,	4.8	01195–02800
	156			11			1.2	
1.2	168	01195–00900*	4.0	15	01195–01900*	13	1.44	01195–02900*
2.4	42		8.0	3.75		26	0.36	
,,	280	01195–01000	,,	25	01195–02000	,,	2.4	01195–03000
	70			6.25			0.6	

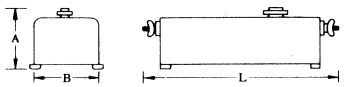
Type GDW Slide Rheostat (double core)

Allowable current (A)	Max. resistance (Ω)	Product ordering code	Allowable current (A)	Max. resistance (Ω)	Product ordering code	Allowable current (A)	Max. resistance (Ω)	Product ordering code
Upper: Series connection Lower: Parallel connection			Upper: Series connection Lower: Parallel connection			Upper: Series connection Lower: Parallel connection		
0.4	6252	01195–06100	2.0	250	01195–06700	8.0	15.0	01195–07300
0.8	1563		4.0	62.5		16.0	3.75	
0.6	2780	01195–06200	2.5	160	01195–06800	10.0	10.0	01195–07400
1.2	695		5.0	40		20.0	2.5	
0.8	1500	01195–06300	3.0	112	01195–06900	13.0	6.0	01195–07500
1.6	375		6.0	28		26.0	1.5	
1.0	1000	01195–06400	4.0	62.5	01195–07000	25.0	1.6	01195–07600
2.0	250		8.0	15.6		50.0	0.4	
1.2	700	01195–06500	5.0	40	01195–07100			
2.4	175		10.0	10				
1.5	444	01195–06600	6.0	28	01195–07200			
3.0	111		12.0	7				

Dimensions

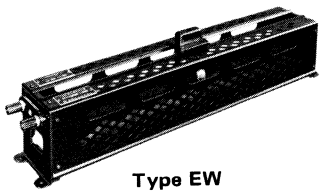


Types EW/DW

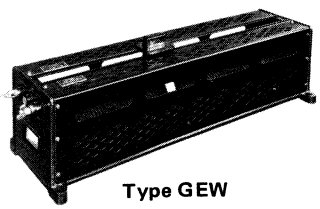


Types GEW/GDW

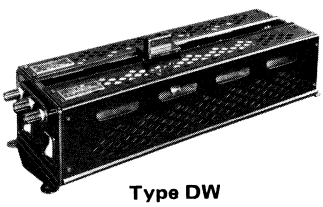
	A (mm)	B (mm)	L (mm)
Type EW	130	85	362*
			517
Type GEW	216	162	745
Type DW	130		362*
			517
Type GDW	225	230	745



Type EW



Type GEW



Type DW

Type GDW

8 MEASURING SETS FOR COMPONENTS & TELECOMMUNICATIONS CABLES

GENERAL INFORMATION

L, C & R MEASURING SETS

Instrument	Model	Freq./voltage	Measurements: Inductance	Measurements: Capacitance	Measurements: Resistance	Measurement range	Other description	Page
Inductance Bridge	AE-27B	300Hz to 500kHz	•			L: 1μH to 300mH, R: 10mΩ to 1kΩ	Companion instruments: TCO-16 Oscillator, ED-7 Detector-amplifier	81
OHM Meter	RM-1B	DC			•	R: 0 to 1000kΩ		82
Wheatstone Bridge	WP-6C	DC			•	R: 0.01Ω to 1MΩ	Fault location is performed by Murray and Varley loop method.	
Insulation Resistance Measuring Set	HR-4G	500V DC			•	R: 1MΩ to 1 x 10^6MΩ		83
	VMG-13B	100 to 500V DC			•	R: 0.1MΩ to 2 x 10^7MΩ		
Highmegohm Meter	VMG-1000	100 to 1000V DC			•	R: 0.05 x 10^2 to 2 x 10^{10}MΩ		84
LCR Meter	AG-4301	100Hz & 1kHz/ 120Hz & 1.02kHz	•	•	•	L: 0.1μH to 9999.9H, C: 0.1pF to 9999.9μF R: 1mΩ to 9.9999MΩ	Q and D measurements can be performed. Digital display.	86
Universal Bridge	LCR-4A	DC, 1kHz	•	•	•	L: 1μH to 100H, C: 1pF to 100μF, R: 1mΩ to 10MΩ	Capable of performing measurements over a wide frequency range using an external oscillator.	88
	LCR-6	1kHz	•	•	•	L: 5μH to 200H, C: 5pF to 200μF, R: 50mΩ to 2MΩ		89
	LCR-10B	1.592kHz	•	•	•	L: 1mH to 10000H, C: 1pF to 10μF, G: 0.1S to 0.01μS	Expansion range (with multiplier): 1μH to 1mH, 10 to 10000μF, 0.1S to 100S	90
LCR Bridge	HBS-5M	R: DC to 30kHz L, C: 1kHz	•	•	•	L: 1mH to 10H, C: 0.001 to 10μF R: 1 to 10000Ω	Companion instruments: TCO-48 Oscillator, ED-9 Detector-amplifier	91

DIELECTRIC LOSS MEASURING SETS

Instrument	Model	Frequency	Measurement range	Other description	Page
Dielectric Loss Measuring Set	TRS-1E	30Hz to 5MHz	Tanδ: 1x10^{-4} to 1x10^{-1}, Capacitance: 10 to 150pF Conductance: 3x10^{-12} to 1.5x10^{-4}S	Suitable for polyvinyl chloride measurement	96
	TRS-4E	0.1 to 10Hz	Tanδ: 1x10^{-3} to 1x10^{-1}, Capacitance: 10 to 1000pF Conductance: 3x10^{-13} to 1x10^{-7}S	Ultra low-frequency measurement	97
	TRS-10T	30Hz to 3MHz	Tanδ: 1x10^{-5} to 1x10^{-1}, Capacitance: 1 to 200pF Conductance: 3x10^{-13} to 1.5x10^{-4}S	Suitable for polyethylene measurement. Wide range	95
Automatic Dielectric Loss Test System	TR-1100	50Hz to 1MHz	Tanδ: 1x10^{-5} to 1x10^{-1}, Capacitance: 1 to 185pF Conductance: f (1x10^{-12} to 1.85x10^{-8})S, f: kHz	Automatic Measurement Wide range	94

MEASURING SETS FOR TELECOMMUNICATIONS CABLES

Instrument	Model	Frequency	Measurement range	Other description	Page
Electrostatic Coupling Measuring Set	CUB-6T	1kHz	±1200pF	Built-in oscillator and detector. Rechargeable battery.	99
	AN-12	1kHz	±3200pF	Built-in oscillator and detector. Battery operated.	
Leakance Bridge	GB-12	1kHz	C: 10pF to 1μF, G: 0.001 to 100μS	Companion instruments: TCO-48 Oscilltor, TA-18 Amplifier	100
High Voltage Test Set	VMG-101	DC	1000 to 5000V DC	Measuring the dielectric strength and corona discharge voltage of coaxial cables.	101
Line Fault Locator	POL-11	2000Hz	C: 200pF to 0.2μF, R: 100Ω to 1MΩ	Locating the short contact and break in rack wirings of telephone exchange and intra-office cables.	102
	WD-18	DC	0 to 1111Ω (in core conductor resistance equivalent.)	Detecting a communication cable fault due to insulation deterioration.	103
	AD-6202	——	Up to 9.99km	Determining the distance and the type of fault such as disconnection, opening, multi-connection, ground, etc.	104
Pair Identifier	AQ-5101	——	——	Two types are available according to uses. Making pair identification of balanced type communications cables.	105
Cable Final Test Set	AH-7101	——	Cables measured: 0.4, 0.5, 0.65, 0.9mm local cables and loading cables.	Measuring the insulation resistance, conductor resistance, near-end crosstalk attenuation and characteristic impedance frequency response.	106
Artificial Telephone Cable	SCK-15	——	Cable diameter: 0.4mm Cable distance: 7.5km	Having electrical characteristics equivalent to actual telephone cables.	108
	SCK-16	——	Cable diameter: 0.5mm Cable distance: 7.5km		
	SCK-17	——	Cable diameter: 0.65mm Cable distance: 20km		
	SCK-18	——	Cable diameter: 0.9mm Cable distance: 47km		
Transmission Simulator	TSE-1	0.3 to 3.4kHz	——	Simulating various transmission characteristics on telephone lines.	109

INDUCTANCE BRIDGE
TYPE AE-27B

This inductance bridge is a direct reading Maxwell bridge (four-arm AC bridge in which inductance is measured as the product of two non-reactive resistors) designed to measure inductance (L) and resistance (R) of various coils. In addition to L and R, I (current) flowing across a test sample can be measured.
The AE-27B features a wide measurement frequency range, a time constant adjuster used to calibrate resistance at higher frequency, a trouble-free transistorized indicating meter, and a LR measurement range expansion (optional).

TYPE AE-27B

SPECIFICATIONS

Range		3 ranges		
		Range 1	Range 2	Range 3
Measurement frequency		0.3 to 500 kHz	0.3 to 100 kHz	0.3 to 10 kHz
Measurement range	L	1μH to 3mH ($f \cdot Lx < 300$)*	10μH to 30mH ($f \cdot Lx < 500$)*	100μH to 300mH ($f \cdot Lx < 1000$)*
	R	10mΩ to 10Ω	100mΩ to 100Ω	1Ω to 1kΩ
	I	30μA to 10mA in 5 ranges		
Resolution	L	0.01μH	0.1μH	1μH
	R	0.1mΩ	1mΩ	10mΩ
	I	2μA, 0.1mA full scale		
Accuracy	L	$\pm (0.2\% + 2 \times 10^{-5} \cdot f^2$ Lx% + 0.2μH)*	$\pm (0.2\% + 2 \times 10^{-5} \cdot f^2 \cdot$ Lx% + 2μH)*	$\pm (0.2\% + 2 \times 10^{-5} \cdot f^2 \cdot$ Lx% + 20μH)*
	R	$\pm (3\% + 5 \times 10^{-5} \cdot f \cdot Q\% + 5 \times 10^{-2} \cdot Q\% + 2.5m\Omega)$*	$\pm (3\% + 5 \times 10^{-5} \cdot f \cdot Q\% + 5 \times 10^{-2} \cdot Q\% + 25m\Omega)$*	$\pm (3\% + 5 \times 10^{-4} \cdot f \cdot Q\% + 5 \times 10^{-2} \cdot Q\% + 250m\Omega)$*
	I	± 2.5% of full scale		
Input level		+26 dBm max.		
Input impedance		600Ω approx.		
Power requirements		100V AC, 50/60Hz		
Dimensions (H x W x D)		Approx. 350 x 425 x 300mm		
Weight		Approx. 16 kg		
Accessories supplied		Tow connecting cables (1m long each), one plug.		
Instruments available		Type TCO-16 Oscillator, Type ED 7 Detector-amplifier, Type LRB-1 LR Expansion Box (the LR expansion box increases measurement range inductance up to 3H and resistance up to 10kΩ)		

* Where f is measurement frequency (kHz), Lx is inductance (mH) of a sample, and Q is quality factor of a sample

WHEATSTONE BRIDGE
TYPE WP-6C

TYPE WP-6C

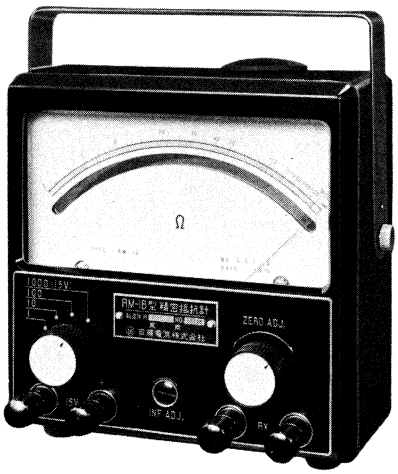
TYPE WP-6C

The WP-6C Wheatstone Bridge is used to measure DC resistance of cables and capable of locating fault of cables. The DC resistance is measured by the wheatstone bridge method, the fault location being performed by Murray and Varley loop methods.

SPECIFICATIONS

Measurement range: 0.01Ω to 1MΩ.
Ratio arms: 0.001-0.01-0.1-1-10-100-1000.
Measurement arm: 1 to 11110Ω (1Ω steps).
Accuracy: ±0.3% (10Ω to 10kΩ).
Power requirements: Internal (two 1.5V dry cells) or external.
Dimensions: Approx. 200(H) x 260(W) x 140(D) mm.
Weight: Approx. 3.2kg.
Accessories supplied: Two dry cells.

OHM METER
TYPE RM-1B



TYPE RM-1B

TYPE RM-1B

The RM-1B is a portable ohm meter designed for easy and direct readings of resistances from 0 to 1000kΩ.

SPECIFICATIONS

Measurement range: 0 to 1000kΩ in four ranges.
x1, x10, x100 ranges – internal dry cells.
x1000 range – external power supply.
Measurement error:

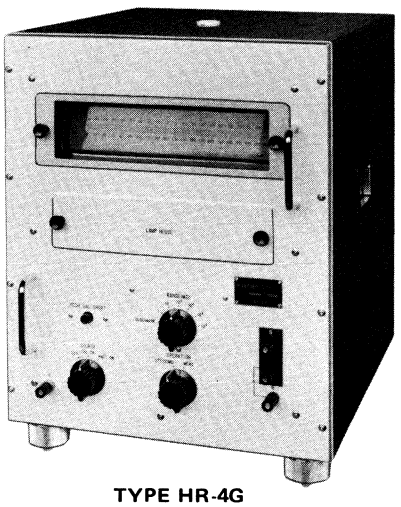
Meter scale (Ω)	Error (Ω)	
	x1 range	x10 range
0 – 10	±0.5	±2
10 – 30		±5
30 – 50	±0.6	±6
50 – 100	±2	±20
100 – 200	±5	±50
200 – 500	±30	±300
500 –1000	±50	±500
x100 range errors: Ten times as large as each error of the x10 range. x1000 range errors: One hundred times as large as each error of the x10 range.		

Dimensions: Approx. 170(H) x 170(W) x 76(D) mm.
Weight: Approx. 2.1kg.
Accessories supplied: Two (1m long) cables, two (0.5 m long) cables.

INSULATION RESISTANCE MEASURING SETS

TYPE VMG-13B/HR-4G

TYPE VMG-13B



TYPE HR-4G

TYPE VMG-13B

The VMG-13B Insulation Resistance Measuring Set measures the DC resistance of cables, insulating materials, etc. at the test voltage 100V, 250V or 500V. The set is housed in a portable carrying case.

SPECIFICATIONS

Test voltage, measurement range & accuracy:

Test voltage (DC)	Measurement range (MΩ)	Meter scale	Accuracy
500V (±5%)	$0.5–5 \times 10^6$ ($0.5–2 \times 10^7$)*	0.5–5.0	±10%
250V (±5%)	$0.25–2.5 \times 10^6$ ($0.25–1 \times 10^7$)*	0.25–2.5	±10%
100V (±5%)	$0.1–1 \times 10^6$ ($0.1–4 \times 10^6$)*	0.1–1.0	±10%

* The range in each parenthesis includes the indicating meter scale range. For these ranges, accuracy is not specified.

Range: x1, x10, $x10^2$, $x10^3$, $x10^4$, $x10^5$, $x10^6$ (seven ranges).
Short-circuit current: 10mA or less.
Insulation resistance (across AC input terminal and case): 50MΩ or more at 500V DC.
Power requirements: 100V AC, 50/60Hz, approx. 15VA.
Dimensions: Approx. 150(H) x 280(W) x 280(D) mm (with front panel cover).
Weight: Approx. 6kg (with front panel cover).
Accessories supplied: One measuring cable (4m long).

TYPE HR-4G

The HR-4G Insulation Resistance Measuring Set is used to measure high insulation resistance of cables, capacitors, insulating materials, etc. It performs the measurement according to direct deflection method, employing a high-sensitive, vibration-proof galvanometer.

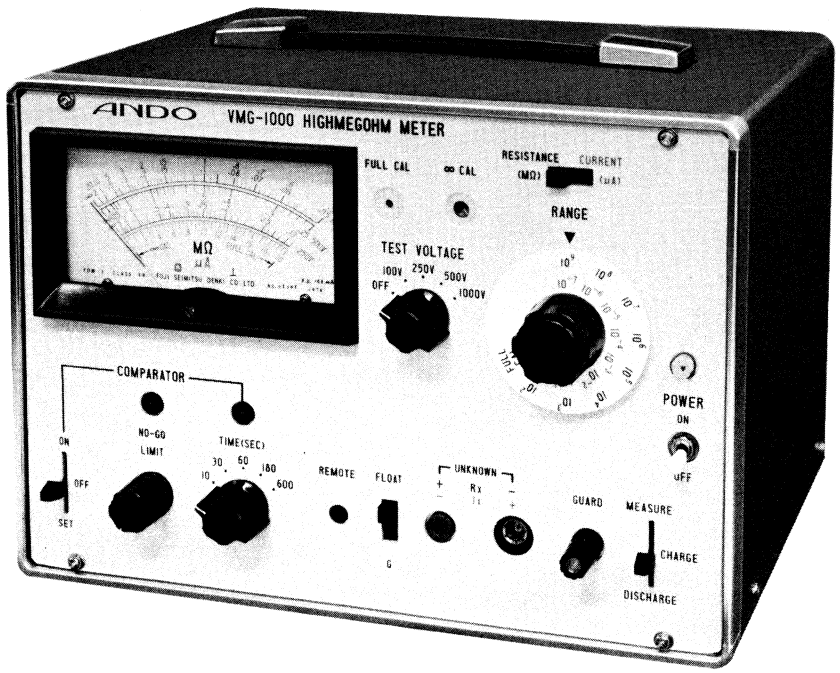
SPECIFICATIONS

Measurement voltage: 500V DC (internal two dry cells).
Measurement range: 1 to 1×10^6 MΩ.
Accuracy: ±10%.
Standard resistor for calibration: 100MΩ (mounted inside).
Power requirements: 100V AC, 50/60Hz or 6V DC (external).
Dimensions: Approx. 440(H) x 360(W) x 400(D) mm.
Weight: Approx. 25kg.
Accessories:
Supplied: Two dry cells.
Optional: Trolley.

HIGHMEGOHM METER

TYPE VMG-1000

- *5 megohms—2× 10^{10} megohms insulation resistance measurement*
- *5×10^{-8}μA—20μA minute current measurement*



The VMG-1000, a portable insulation resistance measuring set, permits accurate and rapid resistance measurements ranging from 5MΩ to 2 x 10^{10}MΩ by using 100V, 250V, 500V, and 1000V as test voltages. It can also measure minute currents as low as 5 x 10^{-8}μA.

The VMG-1000 can perform measurements on the following materials and components: (1) high insulation materials such as high-molecular substances, fiber, porcelain, etc., (2) electrical insulation materials such as synthetic resins, rubber, etc., and (3) electrical components such as printed circuit boards, transformers, switches, capacitors, etc.

FEATURES

- While performing leakage current measurements for samples, each sample can be measured with the same charge time because a timer is employed.
- In addition to resistance measurements, rapid and efficient GO/NO-GO tests are possible because a comparator is employed.
- A recorder output terminal is provided.
- A test voltage remote control terminal is provided for safety during operations.
- Both floating and grounded samples can be measured.
- The following electrode set is optionally available:
  The SE-1000 Electrode Set for volume and surface resistivity measurements of sheet insulation materials.

TYPE VMG-1000, HIGHMEGOHM METER

SPECIFICATIONS, VMG-1000

RESISTANCE MEASUREMENT

Range: 5MΩ to 2 x 10^{10}MΩ in 8 ranges (For test voltage, measurement range and meter scale, see table below).

Accuracy: Between one-third and three-quarters the full scale deflection (7 to 15μA on current scale). ±4.5% for 10^2 to 10^7MΩ ranges, ±8% for 10^8MΩ range, ±10% for 10^9MΩ range.

CURRENT MEASUREMENT

Range: 5 x 10^{-8}μA to 20μA in 8 ranges.

Accuracy: Full scale accuracy. ±2% for 1 to 10^{-4}μA ranges, ±3% for 10^{-5}μA range, ±6% for 10^{-6}μA range, ±8% for 10^{-7}μA range.

Input impedance: 10^4 to 10^{11}Ω, depending on range.

GENERAL

Recorder output: 100mVDC at full scale (into more than 100kΩ load).

Remote control: Test voltage ON-OFF control terminal provided.

Input circuit: Input terminal FLOAT-GND switch provided.

Power requirements: 100V AC, 50/60Hz; approx. 8VA.

Dimensions: Approx. 200(H) x 280(W) x 200(D) mm.

Weight: Approx. 6.3kg

Accessories supplied: Two measuring cables.

Test voltage	100V	250V	500V	1000V
Measurement range	0.05 x 10^2 to 2 x 10^9 MΩ	0.125 x 10^2 to 5 x 10^9 MΩ	0.25 x 10^2 to 10 x 10^9 MΩ	0.5 x 10^2 to 20 x 10^9 MΩ
Meter scale	0.05 to 2	0.125 to 5	0.25 to 10	0.5 to 20

SPECIFICATIONS, SE-1000 ELECTRODE SET (OPTION)

Inner electrode: 50mm diameter.

Guard electrode: 70mm inside diameter, 80mm outside diameter.

Maximum test voltage: DC 1000V.

Sample size: 80 x 80mm (130 x 130 mm. max.).

Dimensions: Approx. 140(H) x 200(W) x 200(D) mm.

Weight: Approx. 5.3kg.

The SE-1000 is specially designed to measure volume and surface resistivity of sheet insulation materials. It is housed in a metal case to eliminate error caused by electrostatic and electromagnetic induction. It is also provided with a safety device.

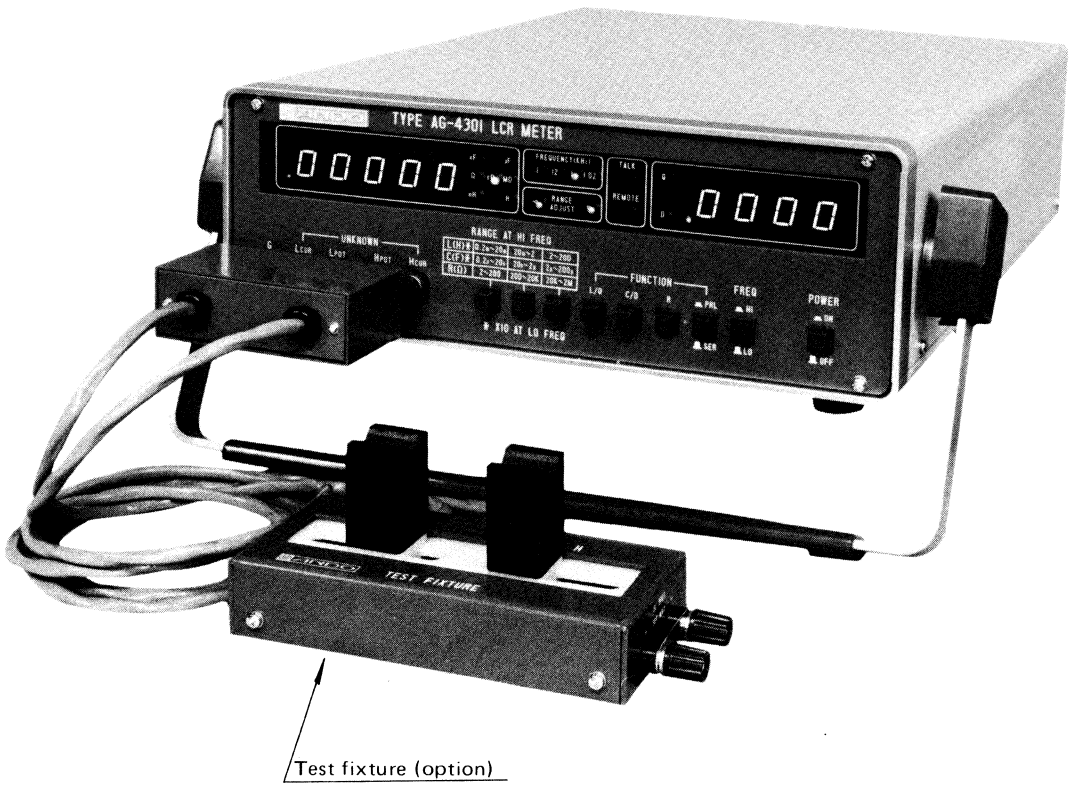
TYPE SE-1000, ELECTRODE SET OPTION

LCR METER

TYPE AG-4301

● *For an economical systems capability* —— GP-IB

A wide measurement range, high measurement accuracy, and a low price



Test fixture (option)

Ando's new AG-4301 digital LCR meter was designed for measuring various circuit components (inductance, capacitance, resistance, etc.) quickly with high accuracy. Unlike conventional bridges which require tedious manual balancing, this digital LCR meter adopts a new method which features ease of operation, excellent stability, and a wide measuring range.

GP-IB and BCD interface options are available for the user that requires a system capability. These interfaces also facilitate the mass selection and acceptance inspection of components in production lines.

FEATURES

- No balancing operation required.
- Two measurement frequencies are selectable.

Frequencies 1kHz and 100Hz or 1.02kHz and 120Hz are easily selectable for characteristic measurements of component parts and circuits.

- Wide measurement range

Since L, C, R, D and Q can be measured over a wide range, this LCR meter meets many of today's requirements for components measurements in the lab., on the production line and in the acceptance inspection area.

- Error-free operation

Since an exclusive jig and test leads are prepared for measuring parts, measurements can be accomplished accurately by the five-terminal method.

- Functions as a system component (option)

GP-IB and BCD interface options offer the improved efficiency of systems automation in which data processing of various characteristics is required.

- Small and light weight

TYPE AG-4301, LCR METER

SPECIFICATIONS

Measurement frequency: 1 kHz and 100 Hz ±0.01% at 50 Hz power line frequency. 1.02 kHz and 120 Hz ±0.01% at 60 Hz power line frequency.

Measurement mode: Series equivalent circuit and parallel equivalent circuit (manual selection).

Measurement parameter: L and Q (L/Q), C and D (C/D), and R (manual selection).

Measurement range:
L: 0.1 μH to 9999.9 H, 3 ranges, manual selection.
C: 0.1 pF to 9999.9 μF, 3 ranges, manual selection.
R: 1 mΩ to 9.9999 MΩ, 3 ranges, manual selection.
Q: 0 to 999.9 .
D: 0 to 9.999 .

Measurement accuracy: Accuracies specified below apply to the measurement ranges listed in the follwoing table.
L measurement:
± (0.2% of rdg. + 2 digits) x (1 + 1/Q).
C measurement:
± (0.2% of rdg. + 2 digits) x (1 + D).
R measurement:
± (0.2% of rdg. + 2 digits).*1
Q measurement:
± [0.4 (1 + Q)% of rdg. + 0.01].
D measurement:
± [0.4 (1 + D)% of rdg. + 0.001].

Applicable measurement ranges for the above all accuracies

Measurement parameter	Measurement frequency	Applicable measurement range		
		Range 1	Range 2	Range 3
L	1kHz or 1.02kHz	0.2000 to 19.999mH	.02000 to 1.9999H	2.000 to 199.99H
	100Hz or 120Hz	2.000 to 199.99mH	0.2000 to 19.999H	20.00 to 1999.9H
C*2	1kHz or 1.02kHz	2.000 to 199.99μF	.02000 to 1.9999μF	0.2000 to 19.999nF
	100Hz or 120Hz	20.00 to 1999.9μF	0.2000 to 19.999μF	2.000 to 199.99nF
R	1kHz or 1.02kHz 100Hz or 120Hz	2.000 to 199.99Ω	0.2000 to 19.999kΩ	.02000 to 1.9999MΩ
Q		00.02 to 999.9		
D		.0020 to 9.999		

*1: When Q or 1/D is 0.01 or less.

*2: When measurement terminal offset capacitance (1.5 pF or less) is subtracted.

Display: L, C and R: 5 digits. D and Q: 4 digits.

Measurement time: 0.5 sec. max.

Measurement voltage: 0.3 Vrms max.

Operating temperature: 0 to 40°C. Measurement accuracies apply over 23 ± 5°C.

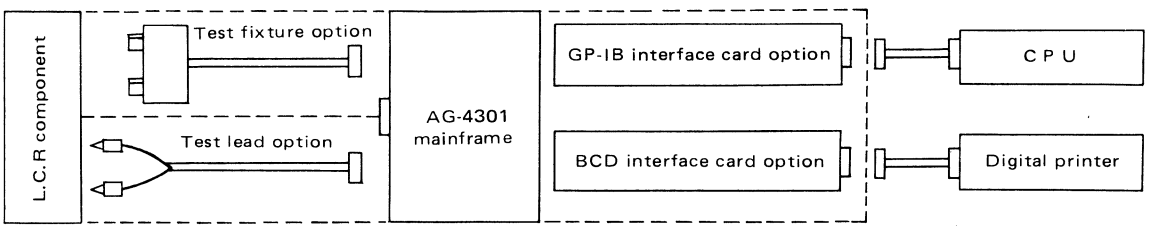
Operating relative humidity: 85% or less. Measurement accuracies apply from 40% to 85%.

Power requirements: 100V AC, 50/60Hz: approx. 40 VA.

Dimensions: Approx. 100(H) x 280(W) x 370(D) mm.

Weight: Approx. 5 kg.

Options: Test fixture, test lead, GP-IB interface card, BCD interface card. Note: both GP-IB and BCD interface cards can not be mounted on the AG-4301 at the same time.



Note: Measurements can also be taken by directly connecting L, C and R components to the terminals on the front panel without using the text fixture and test lead (the five-terminal method).

UNIVERSAL BRIDGE
TYPE LCR-4A

For precision measurements of:
L: 1μH to 100H
C: 1pF to 100μF
R: 1mΩ to 10MΩ (DC, AC)
Q: 0.1 to 1000
Tan δ: 0.001 to 1

Type LCR-4A is a general-purpose universal bridge used for direct-reading measurements of inductance (L), capacitance (C), resistance (R), dissipation factor (D) and storage factor (Q).

The set consists of a bridge, a 1 kHz oscillator, a detector, etc.

An internal 1 kHz oscillator drives the bridge, or an external source (not supplied) can be used for measurements in 100 Hz to 10 kHz.

An internal detector may be used with both the internal and external oscillators. The set can be used for not only AC resistance measurement but also DC resistance measurement.

SPECIFICATIONS

Frequency range: DC and 1 kHz (internal oscillator). 100Hz to 10kHz (external oscillator). Type TCO-48 Oscillator is recommended as an external source.

Measurement range & accuracy: See table below.

Power requirements: 100V AC, 50/60 Hz; approx. 15 VA.
Dimensions: Approx. 300H x 355W x 200D mm.
Weight: Approx. 9 kg.
Accessories supplied: One ear-phone, two test cables.

Item		Measurement range	Accuracy*		Note
			Dial scale	Accuracy	
L		1μH to 100H	10 H or more	± 10%	These specifications apply when Q is ≧ 1.
			100μH to 10H	± (1% + one small division of LRC dial scale)	
			100μH or less	± 2μH	
C		1 pF to 100μF	10 μF or more	± 2%	After the internal capacitances of the test cable and the bridge are properly adjusted.
			100pF to 10μF	± (0.5% + one small division of LRC dial scale)	
			100pF or less	± 2 pF	
R	DC	1mΩ to 10MΩ	1Ω to 10 kΩ	± (0.15% + one small division of LRC dial scale)	
			0.1Ω	± (0.35% + one small division of LRC dial scale)	After the internal resistances of the test cable and the bridge are properly adjusted.
	AC		1Ω to 100kΩ	± (0.5% + one small division of LRC dial scale)	1. When a test sample reactance is as small as the internal reactance of the bridge. 2. For 1Ω or less: After the internal resistances of the test cable and the bridge are properly adjusted.
			1Ω or less & 100kΩ or more	± (1% + one small division of LRC dial scale)	
D		0.001 to 1	0.01μF or more	± (5% + 0.0025)	When measured by connecting a resistance in series to a non-loss sample of 0.01μF or 0.02μF.
Q		0.1 to 1000	———	± (5% + one small division of dial scale)	1. When Q is less than 20, the series connection of a resistance to a sample is necessary. In this case, Q of the sample is referred to the measured value by a Maxwell bridge. 2. When Q is 20 or more, the dial scale must be properly calibrated with DC resistance value, and checked with calculation value.

* Accuracy applies when the bridge is driven by the internal 1 kHz oscillator (except for DC resistance measurement).

UNIVERSAL BRIDGE
TYPE LCR-6

For fast measurements of:
L: 5μH to 200H
C: 5pF to 200μF
R: 50mΩ to 2MΩ
Tan δ: 0.2 to 200%

Type LCR-6 is a general-purpose universal bridge used for direct-reading measurements of inductance, capacitance, resistance and tan δ.
The set consists of an ac bridge, an oscillator, a detector, etc. It can be driven by either the internal oscillator or an external oscillator. The internal detector may be used with both the internal and external bridge drive.
If an electronic voltmeter is used together with this bridge, electric current flowing across the inductance can be measured.

SPECIFICATIONS

Measurement range and accuracy:

	Range	Accuracy *
L	5μH to 200H	±(2% + 3μH), 10 to 200μH ±0.5%, 200μH to 2H ±2%, 2 to 200H
C	5pF to 200μF	±(1.5% + 3pF), 10 to 200pF ±0.5%, 200pF to 2μF ±2%, 2 to 200μF
R	50mΩ to 2MΩ	±(10% + 5mΩ), 0.1 to 2Ω ±1.5%, 2 to 20Ω ±0.5%, 20Ω to 100kΩ ±1.5%, 100kΩ to 2MΩ
Tan δ	0.2 to 200%	For L: ±(8% + loss factor 2 x 10^{-3}), 100 to 200μH ±(5% + loss factor 2 x 10^{-3}), 200μH to 2H ±(8% + loss factor 2 x 10^{-3}). 2 to 200H
		For C: ±(8% + loss factor 2 x 10^{-3}), 100 to 200pF ±(5% + loss factor 2 x 10^{-3}), 200pF to 2μF ±(8% + loss factor 2 x 10^{-3}), 2 to 200μF

* Accuracy applies when the bridge is driven by the internal 1 kHz oscillator.

Minimum scale divisions: R: 0.001Ω.
L: 0.1μH.
C: 0.1pF.
Internal oscillator: 1kHz ±2%, approx. 7V max. output into 1 kΩ load.
External oscillator: (not supplied) 50Hz to 10kHz (ANDO Type TCO-48 Oscillator is recommended when an external oscillator is used).
Internal detector: 50Hz to 10kHz; can be tuned to 1 kHz.
DC bias: Capacitors can be biased to 15V; bias current can be applied to inductors up to 10mA.
Power requirements: 100V AC, 50/60Hz; approx. 4.5VA.
Dimensions: Approx. 250(H) x 320(W) x 200(D) mm.
Weight: Approx. 5.3 kg.
Accessories supplied: One ear-phone.

UNIVERSAL BRIDGE

TYPE LCR-10B

For wide measurements of:
L: 1μH to 10000H
C: 1pF to 10000μF
R: 10mΩ to 100MΩ
G: 0.01μS to 100S
(100μΩ to 10mΩ)

Accurate and precise measurements of inductance, capacitance, resistance, etc. are easily made with Type LCR-10B Universal Bridge.
Measuring frequency covers 50 Hz to 10 kHz and basic measuring accuracy is ±0.2%. The extended measuring range can be obtained by making use of Type MY-1 Multiplier furnished as an accessory (for only internal 1.592 kHz).
The set incorporates a 1.592 kHz oscillator, a 1.592 kHz bandpass filter and a detector.
It employs three-terminal measurement method, which use transformer-ratio-arm bridge to exclude earth admittance.
R measurement can be made in terms of conductance.

SPECIFICATIONS

Measurement range and accuracy:

	Item	Basic	When used with Type MY-1 Multiplier
L	Range	1mH to 10000H	1μH to 1mH
	Accuracy	±0.2%, 1mH to 900H ±5%, 900 to 10000H	±5%
C	Range	1pF to 10μF	10 to 10000μF
	Accuracy	±0.2%, 10pF to 10μF ±5%, 1 to 10pF	±5%
G	Range	0.01μS to 0.1S (100MΩ to 10Ω)	0.1S to 100S (10Ω to 10mΩ)
	Accuracy	±(0.2% +50mΩ resistance), 0.1μS to 0.1S ±5%, 0.01μS to 0.1μS	±5%

Note 1. Accuracy applies when the bridge is driven by the internal 1.592 kHz oscillator.

Note 2. Specified as "$L = \frac{1}{\omega^2 C}$ "

Internal oscillator:	1.592kHz ±1% ($\omega=10^4$).
External oscillator: (not supplied)	50Hz to 10kHz (ANDO Type TCO-48 Oscillator is recommended if an external oscillator is required).
Internal detector:	50Hz to 10kHz; can be tuned to 1.592kHz.
DC bias:	Possible.
Power requirements:	100V AC, 50/60Hz; approx. 20VA.
Dimensions:	Approx. 300(H) x 425(W) x 300(D) mm.
Weight:	Approx. 15 kg.
Accessories furnished:	Type MY-1 Multiplier (this multiplier operates only at internal 1.592 kHz) Two connecting cables. One power cable. Two UNKNOWN terminal adapters.

LCR BRIDGE
TYPE HBS-5M

The HBS-5M is used to measure resistance (from DC to 30kHz), inductance (at 1kHz) and capacitance (at 1kHz). Since the resistance elements of each dial use well-processed non-inductive winding, the bridge is stable to influences from outside temperature and humidity. Measured value can be obtained by means of the following equations:

Resistance measurement (DC):

$$R_X = \frac{R_B}{R_A} \cdot R_C$$

Self-inductance measurement:

$$L_X = \frac{R_B}{R_A} \cdot L_S$$

$$R_X = \frac{R_B}{R_A} \cdot (R_S - R_C)$$ .... when the key is set at the "X" position.

$$R_X = \frac{R_B}{R_A} \cdot (R_S + R_C)$$ .... when the key is set at the "STD" position.

where, L_S = reference inductance
L_X = unknown inductance
R_S = AC resistance of reference inductor
R_X = AC resistance of unknown inductor

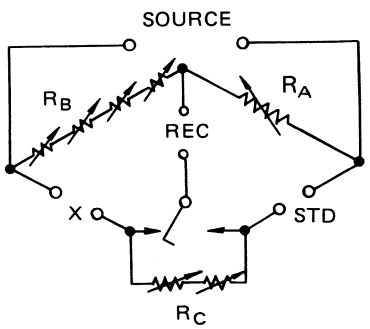
Capacitance measurement:

$$C_X = \frac{R_A}{R_B} \cdot C_S$$

where, C_S = reference capacitance
C_X = unknown capacitance

SPECIFICATIONS

Frequency range:	R measurement: DC to 30kHz L & C measurements: 1kHz
Measurement range:	R: 1 to 10000Ω L: 1mH to 10H C: 0.001 to 10μF
Accuracy:	R: ±(1% + 0.2Ω) from 50 to 5000Ω L: ±(1% + 0.4mH) from 1mH to 5H C: ±(1% + 50pF) from 0.001 to 5μF
Dimensions:	Approx. 250(H) x 400(W) x 155(D) mm
Weight:	Approx. 5 kg
Accessories supplied:	One receiver (headphone)
Instruments available:	Ando Type TCO-48 Oscillator and Type ED-9 Detector-amplifier are recommended.
Other description:	This set has a shielded transformer in the input and output circuit.



Schematic diagram

DIELECTRIC LOSS MEASURING SETS

Dielectric Loss Measuring Sets

The dielectric loss measuring (DLM) set finds wide use in various applications in many branches of science and industry. The most typical uses of them are:

(1) Research for improvement of electric insulators and their characteristic tests;
(2) Determination of the viscosity and elasticity of high polymer materials and of their chemical structures from their dielectric dispersion and absorption;
(3) Determination of moisture content and deterioration of coating, etc.

In recent years the DLM sets have also found use in the fields of biopolymers and foods.

The following advantages of dielectric loss measurement readily explain why DLM sets are in such widespread use.

- The DLM set is capable of measuring the dielectric constant and dielectric loss tangent, the most important parameters of electric properties of insulators.
- The molecular structure, density, and viscosity of high polymer materials can be determined from their dielectric constant and dielectric loss factor.
- Non-destructive measurements can be made.
- The reproducibility of measurements is very high.
- The measuring frequency and temperature can be varied as desired.
- Dielectric loss measurement requires less time than other methods of measurement.

Dielectric Loss Measurement

The DLM set is capable of measuring the dielectric constant, dielectric loss factor, and dielectric loss tangent of various dielectrics. These terms will be explained first.

In Fig. 1 it is assumed that the dielectric between the two electrodes is removed in a vacuum. In this state, the electrostatic capacitance is governed by the shape, dimensions, and arrangement of the electrodes. It is generally referred to as geometrical electrostatic capacitance and expressed as "Co". When AC voltage $\dot{V}$ of frequency "f" is applied to Co, a charging current from one electrode to the other is as follows.

$$\dot{I}o = j\omega\, Co\dot{V} \quad (\omega = 2\pi f)$$

Fig. 2 shows the vector of this current. When the dielectric is put between electrodes, there is an absolute value increase and phase variation in the current ($\dot{I}$). This is referred to as follows.

$$\dot{I} = j\omega \dot{C}\dot{V}$$

The ratio $\dot{\epsilon}$ of $\dot{C}$ to Co is referred to as the complex dielectric constant.

$$\dot{\epsilon} = \dot{C}/Co = \epsilon' - j\epsilon'' \text{ "}$$

Its real part ϵ' is called the dielectric constant and its imaginary part, the dielectric loss factor. Expressing the phase angle of ϵ by tanδ, we obtain

$$\text{Tan}\delta = \epsilon''/\epsilon'$$

Tanδ is called the dielectric loss tangent.

This phenomenon results from a change in the ion arrangement in dielectrics, and provides a means of elucidating the molecular structure, density, and visco-elasticity of various materials.

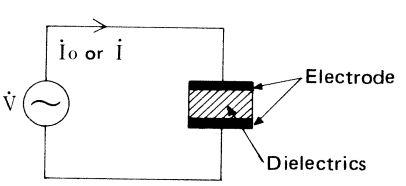


Fig. 1

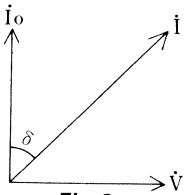


Fig. 2

When tanδ of polar high molecular materials is measured at a fixed temperature, these materials generally show a dielectric absorption maximum at particular frequencies. As this phenomenon is attributable to the molecular structure of each material, the values of tanδ provide a means of clarifying the molecular structure, viscosity, and elasticity of polar high polymer materials. When tanδ of a mixture of two or more different materials is measured, the dielectric absorption maximum appears at a frequency specific for each material. This phenomenon also provides a means of analyzing materials. In the case of nonpolar materials, on the other hand, there is a linear relationship between the dielectric constant and density. This relationship also provides a way of determining the density of nonpolar materials from their dielectric constant.

(1) Since tanδ of a material varies in proportion to the magnitude and number of dipole per c.c. of the material, its tanδ increases when a change in its chemical structure or other changes, such as oxidation and absorption of a polar molecule like water, take place in the substance (Fig. 3). In other words, material deterioration can be known from measurements of tanδ. For instance, the deterioration of high polymer materials and the moisture content of foods and cement can be known from measurements of their tan δ.

(2) When tanδ of polar materials is measured at a fixed temperature while varying frequency "fm," each material shows a maximum tanδ at a specific frequency (Fig. 4). This frequency "fm" changes quantitatively in inverse proportion to the viscosity of the material. In other words, the specific frequency "fm" of each material provides information about its hardening property. For instance, the degree of cure of thermosetting resin and the degree of deterioration of paint can be known from the measurements of "fm".

(3) Theoretically speaking, tanδ is not measured in nonpolar materials, but appears in nonpolar materials containing impurities. This means that the purity of materials can be determined from measurements of tanδ. Furthermore, it is known that there is a linear relationship between dielectric constant ϵ' and density in nonpolar materials like polyethylene. Therefore, the measurement of dielectric constant provides information about the density-related physical properties of nonpolar materials. Utilizing the principles mentioned above, the measurement of tanδ can be employed in wide industrial applications.

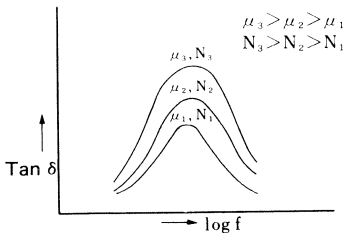


Fig. 3
Tanδ increases in proportion to the magnitude (μ) and number (N) of dipole moments.

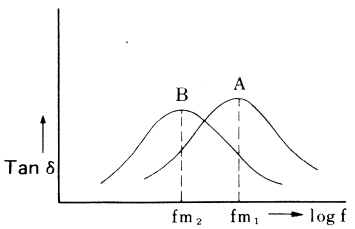


Fig. 4
As "fm" is in inverse proportion to material viscosity, it is evident from the figure that material A is softer than material B.

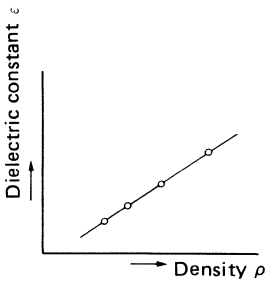


Fig. 5
Relationship between dielectric constant and density.

AUTOMATIC DIELECTRIC LOSS TEST SYSTEM
TYPE TR-1100

This apparatus automatically measures the electrostatic capacity and conductance of various dielectrics over the frequency range from 50 Hz (or 60 Hz) to 1 MHz with the temperature characteristic range from -70 to +199°C.

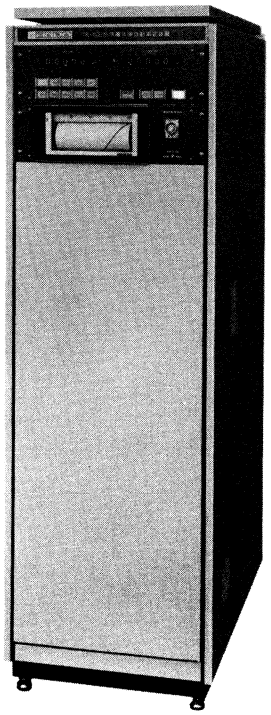
CONFIGURATION

TR-1100 Automatic Dielectric Loss Measuring Set (mainframe; consists of a bridge, an oscillator, a detector, a control circuit and a power supply).
TO-10 Thermostatic Oven (adjustable temperature range from −70 to +199°C).
SE-70 Electrode Set.

FEATURES

- The time required by the conventional manual apparatus is reduced to about 1/50 by this automatic measuring set.
- The substitution method that employs a transformer bridge gives highly accurate, reproducible results.
- Any unskilled person can operate this apparatus and easily read the digital indicator (5 digits).
- BCD output are provided.
- This apparatus can form a system with a minicomputer so that not only the measuring frequency and temperature can be automatically changed but the dielectric characteristics data can be processed by the minicomputer.

- *Automatic testings*
- *Tan δ measurement— 1×10^{-5} to 1×10^{-1}*



MAINFRAME

TR-1100 MAINFRAME SPECIFICATIONS

Frequencies:	50 (or 60), 110, 330 Hz, 1, 3, 10, 30, 100, 300 kHz. 1 MHz (ten frequencies).
Measurement range:	
Tan δ:	1×10^{-5} to 1×10^{-1} (capacitance, 15 pF or more; frequency, 330 Hz or more)
Capacitance:	1 to 185 pF.
Conductance:	f (frequency in kHz)·(1×10^{-12} to 1.85×10^{-8})S.
Display:	5 digits decimal, 19999 max.
Resolution:	
Capacitance:	0.01 pF.
Conductance:	f (frequency in kHz)·(1×10^{-12})S.
Accuracy:	
Tan δ:	±(10% + 3×10^{-5}), 1 to 100 kHz. ±(10% + 2×10^{-4}), 110 Hz or less. ±(10% + 1×10^{-4}), 330 Hz, 300 kHz ±(10% + 2×10^{-4}), 1 MHz.
Capacitance:	±(0.5% + 0.02 pF).
Conductance:	±[5% + f·(frequency in kHz)·2×10^{-12} S], 1 to 100 kHz. ±(5% + 1.8×10^{-12} S), 110 Hz or less. ±(5% + 1.2×10^{-12}S), 330 Hz. ±(5% + 1.2×10^{-9}S), 300 kHz. ±(5% + 6×10^{-9}S), 1 MHz.
BCD output:	1-2-4-8 code (for both capacitance and conductance).
Operating temperature:	+23°C ± 5°C.
Power requirements:	100V AC, 50/60 Hz.
Dimensions:	Approx. 1800H x 540W x 710D mm.
Weight:	Approx. 170 kg.

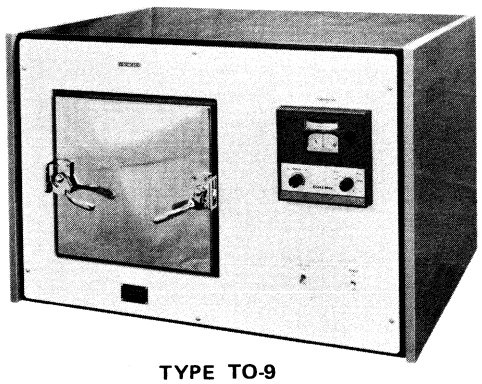
DIELECTRIC LOSS MEASURING SET
TYPE TRS-1E

- *30 Hz to 5 MHz*
  (30 Hz to 1 MHz when an electrode set is used)
- *Tan δ measurement—1×10^{-1} to 1×10^{-4}*

TYPE BDA-9

TYPE WBG-9

TYPE TR-1C



TYPE TO-9

8

STANDARD CONFIGURATION

TR-1C Dielectric Loss Measuring Set (mainframe)
WBG-9 Oscillator
BDA-9 Null Detector
TO-9 Thermostatic Oven
SE-70 Electrode Set (for solid sample measurement)

FEATURES

- The conductance of the sample can be directly read from the apparatus.
- The apparatus can measure the dielectric loss over the wide frequency range (30 Hz to 5 MHz). (The measuring frequency is from 30 Hz to 1 MHz, when the electrode set is used.)
- A wide variety of options (see page 98).
  Electrode sets for solid, liquid and powder sample measurements.

TR-1C MAINFRAME SPECIFICATIONS

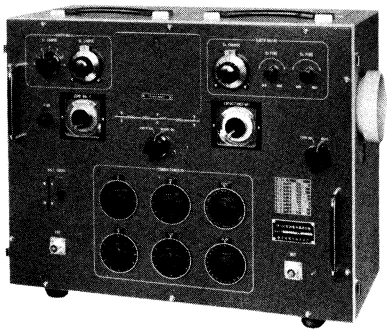
Frequency range:	30 Hz to 5 MHz.
Measurement range:	
Tan δ:	1×10^{-1} to 1×10^{-4}. (capacitance, 50 pF or more; frequency, 110 Hz or more).
Capacitance:	10 to 150 pF.
Conductance:	3×10^{-12} to 1.5×10^{-4} S.
Minimum division:	
Capacitance:	0.1 pF.
Conductance:	3×10^{-12} S, 330 Hz
Measurement accuracy:	
Tan δ:	$\pm(10\% + 1 \times 10^{-4})$.
Capacitance:	±5%.
Conductance:	$\pm(3\% + 3 \times 10^{-12}$S).
Dimensions:	Approx. 300H x 450W x 300D mm.
Weight:	Approx. 10 kg.

DIELECTRIC LOSS MEASURING SET
TYPE TRS-10T

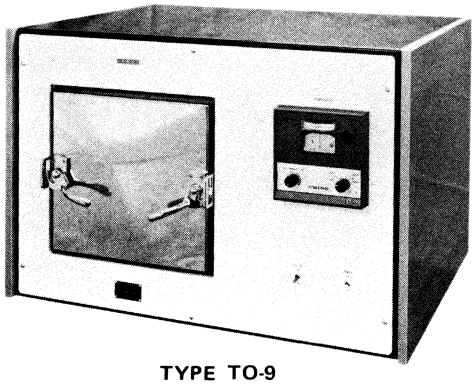
- *Wide frequency range—30 Hz to 3 MHz*
- *Tan δ measurement—1×10^{-1} to 1×10^{-5}*

TYPE BDA-9

TYPE WBG-9



TYPE TR-10C



TYPE TO-9

STANDARD CONFIGURATION

TR-10C Dielectric Loss Measuring Set (mainframe)
WBG-9 Oscillator
BDA-9 Null Detector
TO-9 Thermostatic Oven (adjustable temperature from -70 to +200°C)
SE-70 Electrode Set (for solid sample measurements)

FEATURES

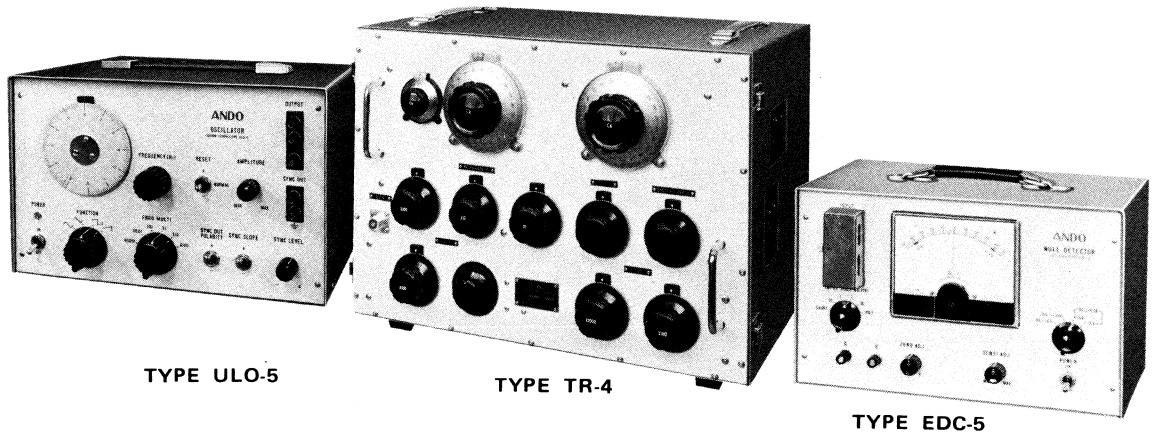
- This apparatus can accurately measure the electrostatic capacity and conductance of polyethylene film having very low value of tan δ down to 10^{-4}.
- The electrostatic capacity and conductance of the sample can be directly read from the apparatus.
- The apparatus can measure the dielectric loss over the wide frequency range.
- The error due to earth admittance at high frequency is eliminated by the use of a Wagner earth circuit.
- A wide variety of options (see page 98)
  Electrode sets for solid, liquid and powder sample measurements.

TR-10C MAINFRAME SPECIFICATIONS

Frequency range:	30 Hz to 3 MHz.
Measurement range:	
Tan δ:	1×10^{-1} to 1×10^{-5}. (capacitance, 50 pF or more; frequency, 110 Hz or more).
Capacitance:	1 to 200 pF.
Conductance:	3×10^{-13} to 1.5×10^{-4} S.
Minimum division:	
Capacitance:	0.01 pF.
Conductance:	3×10^{-13} S, 330 Hz or less
Accuracy:	
Tan δ:	$\pm(10\% + 2 \times 10^{-5})$.
Capacitance:	±3%, 15 to 200 pF.
Conductance:	$\pm(3\% + 3 \times 10^{-13}$ S).
Dimensions:	Approx. 420H x 530W x 300D mm.
Weight:	Approx. 15 kg.

DIELECTRIC LOSS MEASURING SET
TYPE TRS-4E

- *Ultra low frequency—0.1 to 10 Hz*
- *Tan δ measurement—1×10^{-1} to 1×10^{-3}*



TYPE ULO-5 TYPE TR-4 TYPE EDC-5

STANDARD CONFIGURATION

TR-4 Ultra Low-Frequency Dielectric Loss Measuring Set
ULO-5 Ultra Low-Frequency Oscillator
EDC-5 Null Detector
TO-9 Thermostatic Oven
SE-70 Electrode Set (for solid sample measurement)

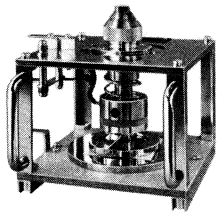
FEATURES

- The dielectric loss can be measured over the extremely low frequency range (0.1 to 10 Hz).
- The conductance of a sample can be directly read from the apparatus.
- The error due to earth admittance is eliminated by the use of a Wagner earth circuit.

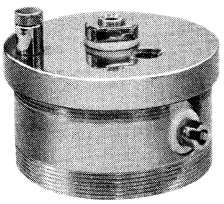
TR-4 MAINFRAME SPECIFICATIONS

Frequency range:	0.1 to 10 Hz.
Measurement range:	
Tan δ:	1×10^{-1} to 1×10^{-3} (capacitance, 50 pF or more; frequency, 1 Hz or more)
Capacitance:	10 to 1000 pF.
Conductance:	3×10^{-13} to 1×10^{-7} S.
Minimum division:	
Capacitance:	1 pF.
Conductance:	1×10^{-13} S.
Measurement accuracy:	
Tan δ:	± (10% + 1×10^{-3}).
Capacitance:	± (2% + 1 pF)
Conductance:	± (5% + 3×10^{-13} S).
Dimensions:	Approx. 330H x 470W x 350D mm.
Weight:	Approx. 16 kg.

AUXILIARY APPARATUS FOR DIELECTRIC LOSS MEASURING SETS

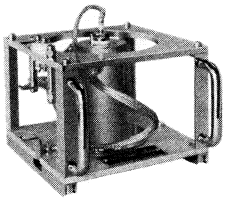


TYPE SE-70

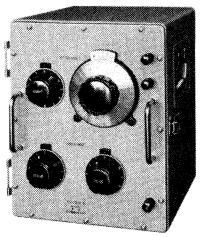


TYPE LE-21

TYPE TO-10



TYPE ADP-203



TYPE YS-1

ELECTRODE SETS

Type	Use	Frequency range	Temperature range	Diameter of electrode	Capacitance	Electrode gap	Matching oven	Dimensions & weight
SE-43	Powder sample	30Hz to 3MHz	-70 to +200°C	17φmm	——	——	TO-9/-10	Approx. 130x122x144mm Approx. 2.5kg
SE-70	Solid sample		-70 to +199°C	19 to 53.7φmm				Approx. 140x125x125mm Approx. 2kg
LE-21	Liquid sample		0 to +100°C	——	Approx. 2pF	Approx. 1.5mm	TO-9/-10, by using the adapter ADP-203	Approx. 40φx30mm Approx. 0.2kg
LE-22					Approx. 17pF			Approx. 40φx75mm Approx. 0.5kg

THERMOSTATIC OVENS

Type	Temperature range	Temperature accuracy	Temperature setting time	Inside dimensions	Matching mainframes	Temperature controller	Cooling	Power requirements	Dimensions & weight
TO-9	-70 to +200°C	±1°C, (under 100°C) ±2°C, (over 100°C)	Approx. 40 minutes (room temp. to +200°C) Approx. 10 minutes (room temp. to -70°C)	Approx. 145x160 x145mm	TR-1C/-4/-10C	Self-contained	Liquid carbon dioxide	100V AC, 50/60Hz	Approx. 470x710x450mm Approx. 60kg
TO-10	-70 to +199°C		Approx. 40 minutes (room temp. to +199°C) Approx. 10 minutes (room temp. to -70°C)		TR-1100				Approx. 470x710x450mm Approx. 65kg

ELECTRODE SET ADAPTER

Type	Use	Matching electrode	Matching oven	Temperature range	Dimensions & weight
ADP-203	Used when mounting an electrode for liquid (LE-21/-22) on a thermostatic oven.	LE-21/-22	TO-9/-10	0 to 100°C	Approx. 140x120x120mm Approx. 1kg

OSILLATORS & DETECTORS

Type	Matching mainframe	Description	Power requirements	Dimensions & weight
WBG-9 Oscillator	TR-1C/-10C	Freq. range: 30, 50, 60, 110, 330Hz, 1, 3, 10, 30, 100, 300kHz, 1, 3, 5MHz Accuracy: ±(0.5% + 1Hz) Max. output: 20V ± 10% (terminated into 200Ω) Output adjustment: More than 20dB	100V AC, 50/60Hz	Approx. 200x350x300mm Approx. 11kg
BDA-9 Null Detector		Performs synchronous detection when used in conjunction with WBG-9 Sensitivity: -90dBm (terminated into 75Ω) Input impedance: More than 1MΩ, less than 30pF (at 1mV level or less)		Approx. 200x350x300mm Approx. 8.5kg
ULO-5 Oscillator	TR-4	Freq. range: 0.0008Hz to 1.2kHz in six bands, continuously variable Accuracy: Within ±(3% + 'FRQ MULTI' x 0.1Hz) Max. output: More than 30Vp-p (terminated into 5 kΩ)		Approx. 200x310x210mm Approx. 8.5kg
EDC-5 Null Detector		Freq. range: DC to 1.2kHz Gain: 10 graduations of output meter range at 1mV input Detection: detecting minimum meter deflection point		Approx. 200x310x225mm Approx. 8.5kg

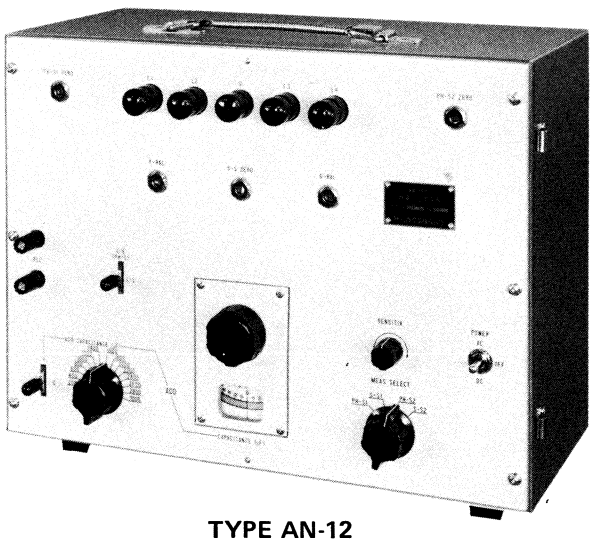
GC BOX

Type	Frequency range	Capacitance	Conductance	Dimensios & weight	Description
YS-1	30Hz to 30kHz	11000pF max.	10000μS max. (in 100μS steps)	Approx. 300x240x250mm Approx. 7.5kg	The ranges of capacitance and conductance measurement can be expanded when this GC Box is used in conjunction with TR-1C/-10C.

ELECTROSTATIC COUPLING MEASURING SETS

TYPES CUB-6T/AN-12

TYPE CUB-6T



TYPE AN-12

These instruments are AC bridges capable of measuring electrostatic coupling both between two pairs of side lines (S-S1, S-S2), and between a phantom circuit and each pair of side lines (PH-S1, PH-S2), in communication cables.
The AN-12 may be used as an unbalance capacity measuring set.
Each instrument has the internal oscillator and detector, and is housed in a single case for carrying convenience, and can be operated from either AC or internal DC.

SPECIFICATIONS

Type	CUB-6T	AN-12
Measuring frequency	1kHz	
Measuring range	±1200pF	±3200pF
Resolution	2pF	
Accuracy	±(1% +2pF)	
Power requirements	Line: AC 100V, 50/60Hz Internal: DC 18V	
Dimensions	Approx. 300(H) x 400(W) x 225(D) mm (with panel cover)	
Weight	Approx. 9kg	Approx. 10kg
Accessories supplied	Measuring cable, headphone, Ni-Cd rechargeable battery	Measuring cable, headphone, 12 dry cells (1.5V x 12)
Remarks		The L-E/L-L selector switch should be set to the L-E position when using the AN-12 as an unbalanced capacity measuring set.

LEAKANCE BRIDGE
TYPE GB-12

The GB-12 Leakance Bridge is used to examine the damping constant of communication cables. The damping constant is expressed as G/2C, where G is conductance and C is capacitance across conductors in a cable. The GB-12 measures resistance and capacitance at 1 kHz. Conductance can be obtained by means of calculating.

SPECIFICATIONS

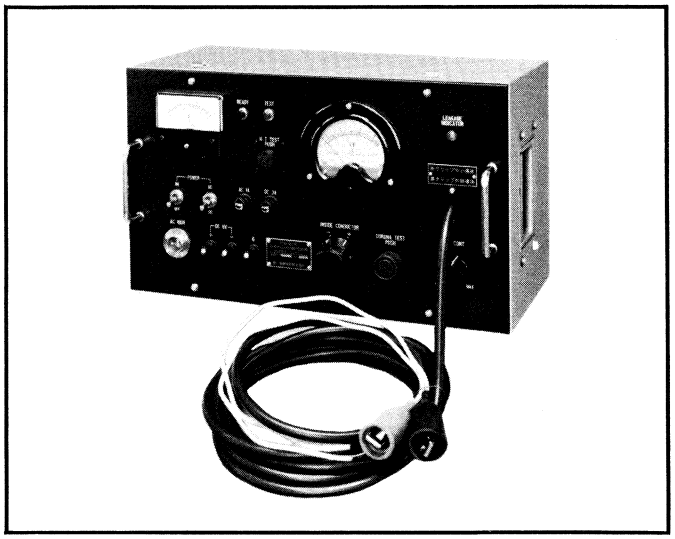
Measurement frequency:	1 kHz.
Measurement range:	C: 10 pF to 1 μF. G: 0.001 to 100 μS.
Resolution:	C: 1 pF. G: 0.001 μS.
Accuracy:	C: ±(1% + 0.5 pF), 10 to 100 pF. ±(0.5% + 5 pF), 100 to 1000 pF. ±0.5%, 1000 pF or more. G: ±5%, 0.1μS dial. ±(3% + 0.01 μS), 1 μS dial. ±(2% + 0.01 μS), 10 μS dial.
Dimensions:	Approx. 350Hx480Wx250D mm.
Weight:	Approx. 17 kg.
Instruments available:	TCO-48 Oscillator and TA-18 Amplifier are recommended.

HIGH VOLTAGE TEST SET
TYPE VMG-101

Type VMG-101 High Voltage Test Set is designed to measure the dielectric strenght and corona-discharge voltage in cores of 9.5mm coaxial cables. There are two types of the VMG-101, office use type and line use type. They are identical to each other except for a connecting device of a test cable.

Office use type: Has a test cable with a terminal plug for connection to a coaxial cable.

Line use type: Has a test cable with insulated clips for connection to a coaxial cable.



SPECIFICATIONS

Output voltage:
- Adjustable range: DC 1 to 5 kV.
- Drift: Within ±100V when continuously measured for 30 minutes at output voltage of 3kV in 10 minutes after the power switch is turned on, provided the power supply voltage does not vary.

Ripple voltage: 1.5% or less of output voltage.

Output current: 1mA or less when the two wires of the test cable are shorted at an output voltage of 5kV.

DC power consumption:
- Test cable shorted: 4A or less at input of DC 6V when measured at output voltage of 5kV.
- Test cable open (no-load): 1.3A or less at input of DC 6V when measured at output voltage 3kV with the wires of the test cable open.

Dielectric strength: There is no abnormality caused when DC7.5kV is applied across high-voltage circuit wire and cabinet for a period of 1 minute.

Insulation resistance:
- Across high-voltage circuit wire and cabinet: 100MΩ or more when measured with DC 1000V.
- Across +, - polarity of high-voltage circuit: 50000MΩ or more when measured with DC 1000V across two wires of the test cable after the corona test pushbotton is depressed.
- Across AC power supply terminals and cabinet: 5MΩ or more when measured with DC 500V.

Output voltage meter:
- Scale: 0, 1000 to 5000V (minimum scale: 100V).
- Scale accuracy: Within ±100V (for 1000 to 3500V)
  Within ±250V (for 3500V or more)

Continuous operation: There is no defect caused upon application of an output voltage of 3000V (no-load) for a two-hour period.

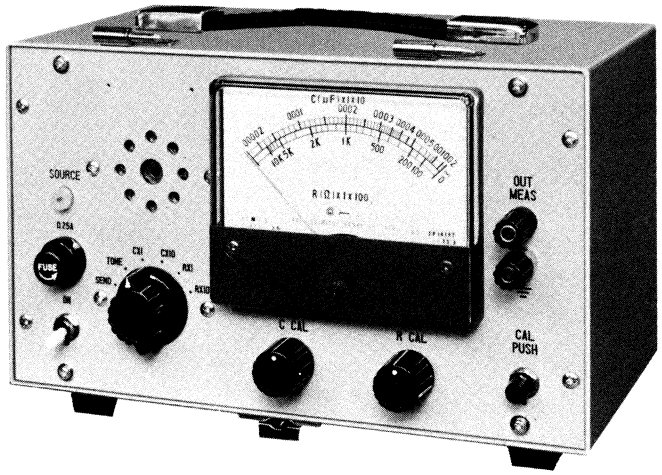
Power requirements: $6^{+0.5V}_{-1.8V}$ DC, approx. 3A; 100V AC 50/60 Hz.

Dimensions: Approx. 250 (H) x 425 (W) x 270 (D) mm.

Weight: Approx. 14 kg.

FAULT LOCATOR
TYPE POL-11

DETECTOR



OSCILLATOR

The POL-11 is a fault locator used to find the short, contact and break in rack wirings of telephone exchanges and intra-office cables.
It consists of an oscillator, which sends a 2 kHz signal to the wirings and cables to be tested, and a pencil-type detector, which is carried along the wirings and cables.
The detector is attached with an earphone for hearing the 2 kHz signal sound. The short and contact in wirings and cables can be sensed from this earphone (when there is a break of the sound, it means there is the short or contact there).
The oscillator can also produce frequencies (500 Hz to 8 kHz, eight frequencies) for detecting the break position in the wirings and cables. It is provided with a speaker on the front panel to make signal tones of these frequencies. The break position can be estimated from the levels of the tones.

SPECIFICATIONS

Oscillator

Function mode:	SEND, TONE, CX1, CX10, RX1, RX100 (switch-selectable).
SEND:	
Sending frequency:	2 kHz ± 10%.
Output voltage:	2.8 Vp-p or more (10 Ω pure resistance load).
Modulation:	50 to 70% modulation (100V AC 50 Hz or 60 Hz).
TONE:	
Frequencies generated:	Approx. 8, 6.5, 5.6, 4.6, 3.3, 2 1, 0.5 kHz (for break test). The tone changes by connecting terminals with wirings or cables to be tested.
Capacitance measurements:	CX1: 200pF to 0.02 μF. CX10: 0.002 to 0.2 μF. Accuracy: ±25%.
Resistance measurements:	RX1: 100 Ω to 10 kΩ. RX100: 10 kΩ to 1 MΩ. Accuracy: ±10%.
Power requirements:	100V AC, 50/60 Hz.
Dimensions:	Approx. 135H x 230W x 145D mm.
Weight:	Approx. 3 kg.

Detector

Detection level (at the position separated by approx. 10 cm from the detector tip; 600 Ω pure resistance, +20 dBm sine wave):

	−40 dBm or more at 500 Hz (600 Ω).
	−30 dBm or more at 2 kHz (600 Ω).
Power requirements:	Internal dry cell (1.5V).
Dimensions:	220 x 22 ϕmm.
Weight:	Approx. 60 g

CABLE FAULT LOCATOR

TYPE WD-18

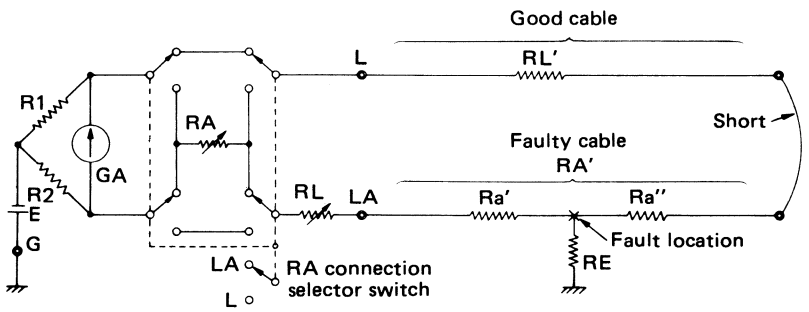
The WD-18 is a portable cable fault locator which easily detects a communication cable fault due to insulation deterioration. The set employs a wheatstone bridge circuit. The measurement can be made by Varley loop method.

FEATURES

- The bridge, null detector and power supply are housed in one compact, lightweight case.
- The detector using a IC-based DC amplifier is capable of adjusting sensitivity. It has such a high level of sensitivity that zero adjustment can be accomplished easily and accurately.
- This apparatus is designed to operate from both DC and AC power so that it can be used in any place where it is needed.
- This apparatus is designed to accept an external high-voltage power supply so that its detecting sensitivity can be increased when it is influenced by an external interference current or when the earth resistance at the defect is high.

SPECIFICATIONS

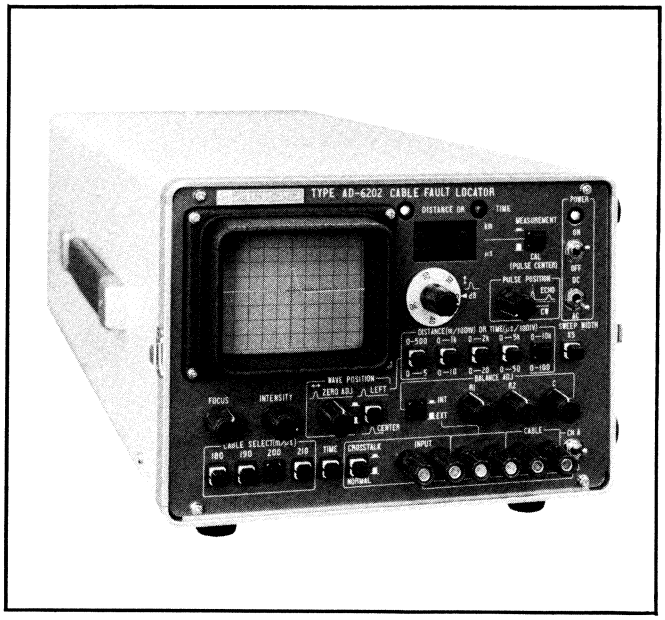
Fault measuring distance:	0 to 1111 Ω (in core conductor resistance equivalent).
Resistance error of the cable distance correction dials and fault distance measuring dials:	± (0.5% + 0.1 Ω).
Power requirements:	100V AC, 50/60 Hz or self-contained DC power supply (-90V for bridge and ±24V for detector). External high-voltage power supply terminals are provided.
Dimensions:	Approx. 250(H) x 350(W) x 240(D) mm including the cover.
Weight:	Approx. 6 kg



Schematic Diagram

CABLE FAULT LOCATOR
TYPE AD-6202

Type AD-6202 Cable Fault Locator is an instrument which utilizes the specific phenomenon called sine-squared pulse echo-back. It is designed to locate such faults as disconnection, opening, multiconnection, and grounding in cables. The pulse propagation time is calculated, and the position of fault or disorder in the cable is indicated by the display of the apparatus in terms of the distance from the apparatus to the fault in the cable.



SPECIFICATIONS

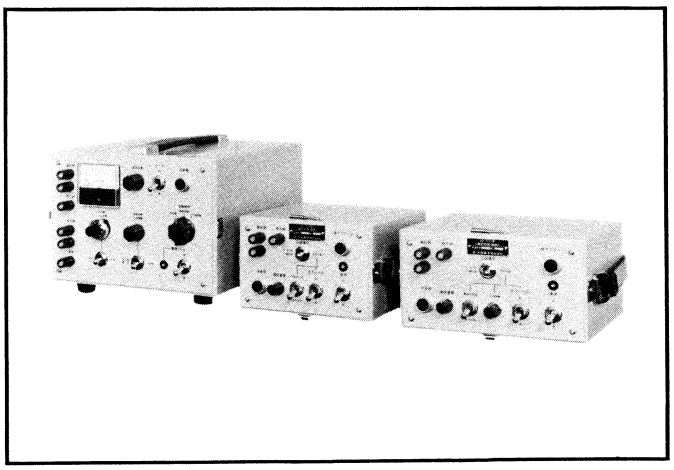
Cable under Test:	Plastic cable, paper insulated cable, coaxial cable.
Sending pulse:	
Waveform:	Sine-squared wave.
Peak value:	30 V or more (into 120Ω load)
Pulse width:	200ns, 500ns, 1μs, 5μs
Measurement item:	Distance (Propagation speed: 180, 190, 200, 210m/μs), time
Distance or time:	0 to 9.99 km or 0 to 99.9μs.
Measurement accuracy:	Readout on CRT screen: Within ±3% Digital readout: Within ±(2%+5m or 0.05μs)
Return loss:	0 to 40 dB adjustable with a reflection level control.
Crosstalk location:	Possible
Comparative measurement:	Possible (with manual switch operation).
Balanced network:	Provided (external balanced network applicable by a switch).
Withstand voltage across terminals:	50V DC or more when measured across the terminals on the front panel.
Sweep width expansion:	Up to 5-fold expansion (except 0 to 500m range).
Insulation Resistance:	More than 5MΩ across the DC input terminal and the case with a 100V megger.
CRT Display:	Dimensions: 8x10 div. (6.35mm/1 div.)
Power requirements:	100V, 115/120V, 220V, 230/240V AC, 50/60 Hz; approx. 33VA Built-in Ni-Cd battery (option); approx. 19VA
Dimensions:	Approx. 150(H) x 210(W) x 485(D)mm
Weight:	Approx. 11kg (including the cover and the Ni-Cd battery).

PAIR IDENTIFIER
TYPE AQ-5101

The AQ-5101 Pair Identifier is designed for making pair identification of balanced type communications cables about idle lines, working lines and PCM lines. It examines a break of the cables due to cable deterioration or a connection of the cables by conductor numbers. It can also identify a tip-ring on data communications circuits without affecting the circuit transmission in operation.
The following three models are available:

Type AQ-5101 Pair Identifier (Office)
Type AQ-5101 Pair Identifier (Line A)
Type AQ-5101 Pair Identifier (Line B)
Type AQ-5101 Pair Identifier (Probe)

Identifiers, Line A and Line B, consist of a mainframe and a search probe.



SPECIFICATIONS

AQ-5101 Pair Identifier (Office)

Working circuit identification:

Search line input characteristics	Center frequency		3450 ±2 Hz
	Min. input sensitivity		-75 ±4 dBm
	Common mode rejection ratio		50 dB or more
Busy line minimum	input sensitivity		-70 dB or less
Busy line output characteristics	1	Frequency	300 ±30 Hz
		Outupt level	-10 ±3 dBm
	2	Frequency	1000 ±100 Hz
		Output level	-30 ±3 dBm
Idle condition detecting characteristics	Termination resistance		1kΩ ±100Ω

Idle line identification:

Search line output characteristics	Frequency	270 ±27 Hz
	Output level	-10 ±3 dBm
Busy line output characteristics	Frequency	1000 ±100 Hz
	Output level	-30 ±3 dBm
Comparator resolution		10% or less

Talking circuit gain: 25 dB or more.

AQ-5101 Pair Identifier (Line A)

Working circuit identification:
- Oscillation frequency: 3450 ±2 Hz
- Probe terminal output level: 1. -50 dBm or more, -47 dBm or less. 2. -60 dBm or more, -57 dBm or less
- Talking terminal output level: -47 ±2 dBm

Idle line and PCM line identification:
- Gain at 1005 Hz center frequency: 50 ±2 dB
- 3 dB bandwidth from 1005 Hz center frequency: 105 Hz or less
- Talking circuit gain: 25 dB or more

AQ-5101 Pair Identifier (Line B)

Working circuit identification:
- Probe terminal output level: -50 dBm or more, -47 dBm or less.

Idle line and PCM line identification:
- Gain at 1005 Hz center frequency: 50 ±2 Hz
- 3 dB bandwidth from 1005 Hz center frequency: 105 Hz or less.
- Talking circuit gain: 25 dBm or more.

Probe

Signal transmission level: 1. -50 dBm or more, -47 dBm or less. 2. -60 dBm or more, -57 dBm or less.

General

Power requirements: 100V AC, 50/60 Hz or external DC (+9 to +13V DC and -9 to -13V DC).

Dimensions and weight:
- AQ-5101 (Office): Approx. 150(H) x 210(W) x 255(D) mm, approx. 5.5 kg
- AQ-5101 (Line A): Approx. 100(H) x 150(W) x 195(D) mm, approx. 3 kg
- AQ-5101 (Line B): Approx. 100(H) x 180(W) x 195(D) mm, approx. 3.5 kg

Accessories supplied: Handset cable, search cable, fuses, bag for cable.

Option: Headset for line test.

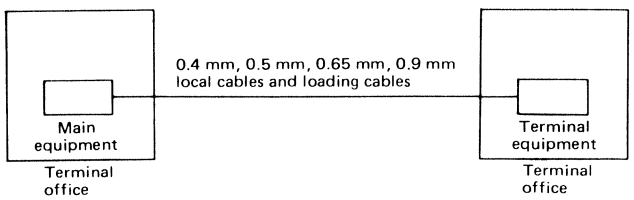
CABLE FINAL TEST SET
TYPE AH-7101

TERMINAL EQUIPMENT

MAIN EQUIPMENT

The cable final test set measures the insulation resistance, conductor resistance, near-end crosstalk attenuation and characteristic impedance frequency response between terminal offices of trunk cables as installed. The cables which can be measured include 0.4 mm, 0.5 mm, 0.65 mm, 0.9 mm local cables and loading cables (for type B100).
The cable final test set is composed of a main equipment and a terminal equipment. While keeping liaison between terminal offices with the main equipment placed in one terminal office and the terminal equipment in the other, this set can be used to measure the following items.
Measurement items:

(1) Insulation resistance
(2) Conductor resistance
(3) Near-end crosstalk attenuation
(4) Characteristic impedance frequency response



FUNCTIONS

(1) Automatic measurement of the insulation resistance, conductor resistance and near-end crosstalk attenuation per quad, and automatic measurement of the characteristic impedance frequency response can be made.
(2) Test items and test start line Nos. can be set arbitrarily, and when the measurement of one test item is completed, switching to the next line No. is automatically accomplished.
(3) Either automatic measurement or manual measurement can be specified.
(4) For the near-end crosstalk attenuation measurement, the terminating resistance can be set appropriately for the cable to be measured.
(5) Start or reset can be done arbitrarily.
(6) The cable No. under test and measuring frequency can be digital-displayed in a 4-digit form, and the measured value in a 5-digit form.
(7) The cable No. under test, measured value and frequency (in the characteristic impedance measurement only) are printed by a built-in printer. When the equipment is in the automatic measurement mode.
(8) For the main equipment, calibration of the insulation resistance, conductor resistance, near-end crosstalk attenuation, and characteristic impedance (absolute value and phase angle) can be done.

TYPE AH-7101, CABLE FINAL TEST SET

SPECIFICATIONS

Insulation resistance measurement

Item	Specifications	Remarks
Measurement voltage	DC 100V ± 10%	
Measurement range	1 to 50 MΩ	Resolution 1 MΩ
Measurement accuracy	±10%	As tested with the specimen of 55 MΩ resistance shunted by a capacity of 2 μF, and 45 MΩ resistance

Conductor resistance measurement

Item	Specifications	Remarks
Measurement current	DC 1 mA ± 10%	
Measurement range	0 to 10000Ω	Resolution 1Ω
Measurement accuracy	± (0.3% + 2Ω)	

Near-end crosstalk attenuation measurement

Item	Specifications		Remarks
Measurement frequency	1 kHz ± 5%		
Measurement level	±3 dBm		1600Ω resistance termination
Output impedance	50Ω or less		
Termination resistance	Calibration	600Ω ± 5%	Main equipment only
	0.4 mm non-loading	941Ω ± 5%	Main equipment Terminal equipment
	0.5 mm non-loading	752Ω ± 5%	
	0.65 mm non-loading	579Ω ±5%	
	0.9 mm non-loading	419Ω ± 5%	
	Loading	1547Ω ± 5%	
Measurement range	40 to 85 dB		Resolution 1 dB
Measurement accuracy	±1 dB (40 to 69 dB) ±2 dB (70 to 85 dB)		With the impedance compensation circuit not in use

Characteristic impedance measurement

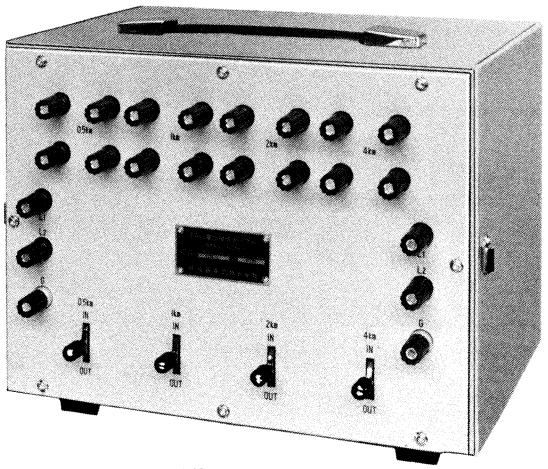
Item	Specifications		Remarks
Measurement frequency	250 to 4000 Hz in 250 Hz steps (16 frequencies)		
Frequency accuracy	±5%		
Measurement current	1 mA ± 10% from absolute value 100 to 1000Ω 0.1 mA ± 10% from absolute value 1000 to 10000Ω		
Measurement range	Absolute value	100 to 10000Ω	Resolution 0.1Ω (from 100 to 1000Ω) Resolution 1Ω (from 1000 to 10000Ω)
	Phase angle	−90 to + 90 deg.	Resolution 0.1 deg.
Measurement accuracy	Absolute value	From frequency range 250 to 4000 Hz ± (1% + 1 digit) (from 100 to 3000Ω) ± (2% + 1 digit) (from 3000 to 10000Ω)	With the impedance compensation circuit not in use
	Phase angle	From frequency range 250 to 4000 Hz ± 1 deg. (from absolute value 100 to 3000Ω) ± 2.5 deg. (from absolute value 3000 to 10000Ω)	

General

Power requirements	100V, 110V, 210V, 220V AC, 50/60 Hz	
Dimensions & weight (including front panel cover)	Main equipment	Approx. 300 (H) x 520 (W) x 500 (D) mm. Approx. 35 kg
	Terminal equipment	Approx. 150 (H) x 280 (W) x 235 (D) mm. Approx. 6 kg

ARTIFICIAL TELEPHONE CABLES
TYPES SCK-15/16/17/18

These artificial cables are designed to have the electric characteristics of quad type lead sheathed city cables that contain wires 0.4, 0.5, 0.65, or 0.9 mm in diameter. The cable-to-cable and the cable-to-ground capacitances are separately provided for dial impulse transmission measurements.



TYPE SCK-15

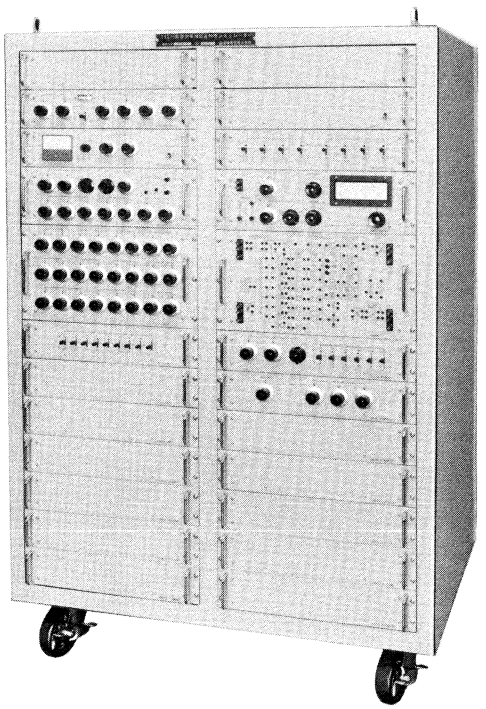
SPECIFICATIONS

Type	SCK-15	SCK-16	SCK-17	SCK-18
Artificial extreme cable length	7.5 km (0.4 mm)	7.5 km (0.5 mm)	20 km (0.65 mm)	47 km (0.9 mm)
Composition	0.5 + 1 + 2 + 4 km	0.5 + 1 + 2 + 4 km	1 + 2 + 2 + 5 + 10 km	2 + 5 + 10 + 10 + 20 km
Accuracy	Resistance: Within ±0.2% Capacitance: Within ±2% at 1 kHz			
Dimensions (H x W x D)	Approx. 220 x 300 x 250 mm		Approx. 220 x 350 x 250 mm	
Weight	Approx. 8 kg	Approx. 8 kg	Approx. 10 kg	Approx. 12 kg

VOICE BAND TRANSMISSION SIMULATOR

TYPE TSE-1

- *Simulates various transmission characteristics on telephone lines*
- *0.3 to 3.4 kHz*



The TSE-1 is a full-scale simulator of the characteristics of transmission circuits (especially telephone circuit network). It can easily test the phase characteristics of transmission circuits and also provides for separate testing of amplitude characteristics and group delay frequency characteristics in the case of the carrier communication link. This equipment therefore provides for analytical tests which cannot be performed in practical (real) circuits.

FEATURES

- Various characteristics of practical (real) circuits can be easily simulated in a laboratory.
- All simulation functions are independent of one another and all inputs and outputs are concentrated on the front panel for ease of operation.

FUNCTIONS

1. Attenuation characteristics simulation circuits
   - 0.4 mm non-loading cable (4 km x 2)
   - Carrier links (1 to 7)
   - Variable characteristics
     (primary characteristics, stepwise)
   - Hump characteristics
     (pitch and amplitude variable)
2. Group delay frequency characteristics simulation circuits
   - Loading cable (15 km x 2)
   - Carrier links (1 to 7)
   - Variable characteristics
     (primary characteristics, stepwise)
   - Hump characteristics
     (simultaneously variable with the attenuation characteristics)
3. Listener's echo of 0 to 12 ms
4. Phase hit of 0 to 180°
5. Sine wave phase jitter within ±45°
6. Frequency deviation within ±20 Hz
7. Level hit setting (stepwise)
8. Level variation of −20 to +5 dB (continuously variable)
9. White noise generation
10. 2nd and 3rd higher harmonics setting

GENERAL

Frequency range:	0.3 to 3.4 kHz
Input/output impedance:	600Ω balanced
Maximum working level:	+10 dBm
Power requirements:	100V AC, 50/60Hz
Dimensions and weight:	Approx. 1660(H) x 1100(W) x 700(D) mm. Approx. 400 kg

9 MEASURING SETS FOR FDM COMMUNICATIONS & TRANSMISSION CHARACTERISTICS

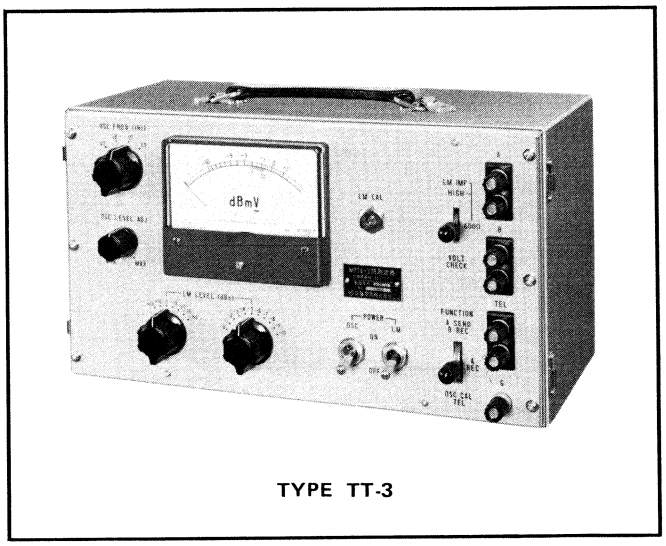
GENERAL INFORMATION

INSTRUMENTS SELECTION CHART

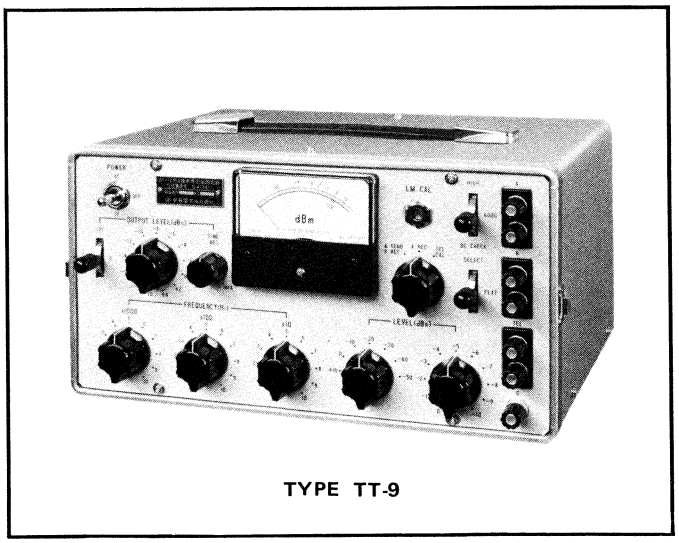
Instruments	Model	Frequency range	Voice band	G band	SG band	MG band	SMG band	Page
Oscillator	TCO-47	10Hz to 2MHz	●	●	●	●		27
	TCO-48	10Hz to 2MHz	●	●	●	●		
Frequency Synthesizer	AJ-2600	10Hz to 2MHz	●	●	●	●		16
	AJ-2700	2kHz to 30MHz		●	●	●	●	18
	AJ-2730	10Hz to 30MHz	●	●	●	●	●	20
	AJ-2731	10Hz to 30MHz	●	●	●	●	●	22
	AJ-2750B	1mHz to 30MHz	●	●	●	●	●	24
Level Meter	TLM-35B	200Hz to 2MHz	●	●	●	●		44
	TLM-36B	10Hz to 20kHz	●					
	AD-4730	10Hz to 30MHz	●	●	●	●	●	42
Selective Level Meter	AD-2430	20Hz to 20kHz	●					45
	AD-2530	200Hz to 200kHz	●	●				
	AD-2630	800Hz to 2MHz		●	●	●		
	AD-2730	10kHz to 30MHz		●	●	●	●	
	AD-2750B	200Hz to 30MHz	●	●	●	●	●	48
	AD-2700	200Hz to 30MHz	●	●	●	●	●	47
Standard Level Calibration Set	AD-4030	DC, 20Hz to 1000MHz	●	●	●	●	●	52
Amplifier	TA-2A	1kHz	●					62
	TA-18	30Hz to 10kHz	●					
	TA-15B	3kHz to 150kHz		●				
	TA-21	10kHz to 50MHz			●	●	●	
Attenuator	AL-205	DC to 150kHz	●	●				64
	AL-255	DC to 150kHz	●	●				
	AL-352	DC to 700kHz	●	●				
	AL-401	DC to 50MHz		●	●	●	●	65
	AL-4550	DC to 200kHz	●					66
	AL-4551	DC to 500kHz	●	●				
	AL-4750	DC to 30MHz			●	●	●	
Impedance Measuring Set	DRZ-1	200Hz to 5kHz	●					76
	DRZ-2M	200Hz to 100kHz	●	●				
	DRZ-3	3kHz to 150kHz		●				
	DRZ-4	10kHz to 500kHz		●	●			
Return Loss Measuring Set	UM-11B	30Hz to 150kHz	●	●				77
	UM-14	50kHz to 17MHz		●	●	●	●	
Transmission Measuring Set	TT-3	300Hz to 3.4kHz	●					111
	TT-9	200Hz to 10kHz	●					
	PMS-6C	100Hz to 2MHz	●	●	●			112
	AH-4730D	10Hz to 30MHz	●	●	●	●	●	114
	TT-170/171/172	40Hz to 15kHz	●					117
	TT-180/181/182	60kHz to 550kHz		●	●			
	VST-251B/252B/253B	300Hz to 150kHz	●	●				120
	VST-24	50kHz to 7MHz		●	●	●		121
	VST-20B	300Hz to 2.1MHz	●	●	●	●		
Transmission Characteristics Curve Tracer	TV-33	200Hz to 50kHz	●					123
	TV-37	60kHz to 560kHz		●	●			
Psophometer	AD-9430	30Hz to 16kHz	●					126
	NM-36	30Hz to 31.5kHz	●					125
Weighting Network	NW-1	1kHz to 150kHz	●	●				128
Crosstalk Measuring Set	PX-1	1kHz to 150kHz	●	●				129

TRANSMISSION MEASURING SETS

TYPES TT-3/9



TYPE TT-3



TYPE TT-9

Type TT-3 and Type TT-9 Transmission Measuring Sets are portable test sets used for measuring levels in frequency ranges from 0.3kHz to 3.4kHz and 0.2kHz to 10kHz respectively.
Each set is composed of an oscillator section and a level meter section, and can be operated from either AC or DC.

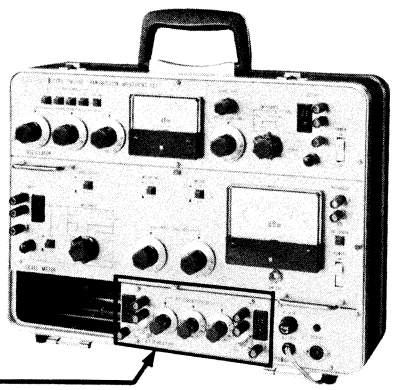
SPECIFICATIONS

Type		TT-3	TT-9
Oscillator section	Frequency range and accuracy	0.3kHz±4%, 1kHz±3%, 1.5kHz±2%, 2.5kHz±2%	0.2 to 10kHz, ± (0.4% + 2Hz)
	Output level	-15 to +10dBm	-40 to +4dBm
	Output impedance	600Ω balanced	600Ω balanced
	Distortion	25dB or more	30dB or more
Level meter section	Frequency range	0.3 to 3.4kHz	0.2 to 10kHz
	Measurement range	-50 to +20dBm	-60 to +10dBm
	Frequency response	±0.5dB (at 0.3 to 3.4kHz and 1kHz reference)	±0.5dB (after calibration at 1kHz)
	Level indication stability	±0.5dB (17 to 20V DC, 20±15°C)	±0.5dB (17 to 23V DC, 20±15°C)
	Input impedance	600Ω/high, balanced	600Ω/high, balanced
Power requirements		100V AC, 50/60Hz or 22.5V DC (external)	100V AC, 50/60Hz or 22.5V DC (external)
Dimensions (H x W x D)		Approx. 170 x 300 x 170mm	Approx. 150 x 280 x 250mm
Weight		Approx. 6.4kg	Approx. 7.5kg
Accessories supplied		One carrying case	———
Accessories available		Optional dry cell case	Optional dry cell case

TRANSMISSION MEASURING SET
TYPE PMS-6C

- *100 Hz to 2 MHz*
- *Small and compact*
- *Housed in a portable carrying case*
- *Operated from both AC and DC (option)*

← The accessory case is available for storing the optional attenuator, battery charger, rechargeable battery pack, dry cell case, and cables.



The optional attenuator (Type AL-2670A) can be housed in the lower part of the case. →

The PMS-6C is a portable test set designed for transmission characteristics measurement on carrier communication systems including FDM system. The set measures level, gain, loss and noise in the frequency range of 100 Hz to 2 MHz. It consists of an oscillator and a level meter.

FEATURES

- Easy to operate because measurement is made by means of the direct deflection method.
- Housed in a portable metal (aluminum) case.
- The level meter unit can be removed from the combining case, and therefore it can serve as a single set. The unit features an expanded meter range, a recorder output and a weighting network.

GENERAL SPECIFICATIONS

Frequency range: 100 Hz to 2 MHz
Measurment range:

Level:	−69 to +30 dBm (with meter range)
Gain:	0 to 50 dB
Loss:	0 to 75 dB
Impedance:	600Ω/high, balanced (0.1 to 200 kHz)
	150Ω/high, balanced (3 kHz to 1 MHz)
	75Ω/high, balanced (3 kHz to 1 MHz)
	75Ω unbalanced (0.1 kHz to 2 MHz)

TYPE PMS-6C, TRANSMISSION MEASURING SET

SPECIFICATIONS

OSCILLATOR UNIT

Frequency range and accuracy	0.1kHz to 2MHz, ±(2% + 5Hz) 0.2 to 200kHz, ±(1% + 2Hz)			
Output impedance	600Ω ± 20% (balanced), 0.1 to 200kHz 150Ω ± 20% (balanced), 3kHz to 1MHz 75Ω ± 20% (balanced), 3kHz to 1MHz 75Ω ± 20% (unbalanced), 0.1kHz to 2MHz			
Output level	-30 to +15 dBm in 5 dB steps (meter scale, -5 to +1 dBm)			
Frequency response (10 kHz, +15 dBm reference)	600Ω balanced	150Ω balanced	75Ω balanced	75Ω unbalanced
	±1 dB 0.1 to 200kHz	±1 dB 3kHz to 1MHz	±1 dB 3kHz to 1MHz	±1 dB 0.1kHz to 2MHz
	±0.5 dB 0.2 to 120kHz	±0.5 dB 10 to 650kHz	±0.5 dB 10 to 650kHz	±0.5 dB 0.2 to 650kHz
Distortion	30 dB or more, both for 2nd and 3rd harmonics (referred to 0.2 to 650kHz and +15 dBm)			

LEVEL METER UNIT

Measurement range	-69 to +30 dBm (covers -59 to +20 dBm by using two dials; covers -10 to +2 dBm with meter; +30 dBm level can be measured only when terminated into 600Ω). ±1.5 dBm expanded meter range provided.			
Frequency range	600Ω balanced	150Ω balanced	75Ω balanced	75Ω unbalanced
	0.1 to 200kHz	3kHz to 1MHz	3kHz to 1MHz	0.1kHz to 2MHz
Input impedance	10kΩ or more, 0.2 to 120kHz 8kΩ or more, 0.1 to 200kHz	2kΩ or more	1kΩ or more	
	600Ω ± 1% pure resistance may be bridged	150Ω ± 1% pure resistance may be bridged	75Ω ± 1% pure resistance may be bridged	75Ω ± 20%
Frequency response (10kHz, 0 dBm reference)	±2 dB, 0.1 to 200 kHz	±1dB 3kHz to 1MHz	±1dB 3kHz to 1MHz	±2 dB, 0.1 kHz to 2MHz
	±1 dB, 0.2 to 200 kHz	±0.5 dB 10 to 650kHz	±0.5 dB 10 to 650kHz	±1 dB, 0.1 kHz to 1MHz
	±0.5 dB, 0.2 to 120 kHz			±0.5 dB, 0.2 to 650kHz
Weighting network	Telephone (CCITT psophometric; 100Hz to 5kHz)			

GENERAL

Calibration: Oscillator output level can be calibrated by the use of the level meter unit which is interlocked with the oscillator unit.

Power requirements: AC: 100V ± 10%, 50/60Hz; approx. 8VA.
DC: ±14V, a rechargeable battery pack and a dry cell case are available as optional accessories.

Dimensions: Approx. 300H x 410W x 120Dmm (including panel cover).

Weight: Approx. 7.5 kg.

Accessories supplied: Two cables, 2m long each (both ends terminated with M1PS connectors).
Two cables, 2m long each (one end terminated with SP connector, the other end with BNC connector).

Accessories available: Accessory case (used to accommodate accessories; dimensions, approx. 300H x 410W x 100Dmm).
AL-2670A variable attenuator: 600Ω (balanced) and 75Ω (unbalanced), 61dB max. in 0.1dB steps, three dials.
Fixed attenuators: 75Ω, 10dB (or 20dB), 5W.
Battery charger.
Rechargeable battery pack: ±14V; continuous operating time, four hours.
Dry cell case.
Measurement cables, 2m long each (terminated on both ends with I-214APS or BNC connectors; terminated on one end with a I-214APS connector and on the other end with a M1PS connector).

TRANSMISSION MEASURING TEST SET

TYPE AH-4730D

- *Wide frequency range – 10Hz to 30MHz*
- *Portable and easy-to-use*

AH-7430D

From top in the photo:
AD-4730 Level Meter
AJ-2730 Frequency Synthesizer
AL-5730 Switching Unit

The AH-4730D is a transmission measuring set having a wide frequency range from 10Hz to 30MHz.

It can efficiently measure gains and losses in transmission lines, carrier systems and various electronic circuits with high accuracy and precision.

The set consists of:

Type AJ-2730 Frequency Synthesizer
Type AD-4730 Level Meter
Type AL-5730 Switching Unit

The switching unit includes an attenuator section (attenuation range from 0 to 91dB in 0.1dB steps).

FEATURES

- Ranges widely from 10Hz to 30MHz.
  Basic range: 10Hz to 20MHz.
  Extension range: 20 to 30MHz (a terminal in the rear of the frequency synthesizer facilitates measurements up to 30MHz).
- Because the frequency synthesizer is utilized, highly accurate frequencies can be obtained (synthesizer frequency accuracy, $\pm 5 \times 10^{-5}$).
- The level meter employs an automatic expander system (The dB meter deflection is automatically changed from normal mode to expansion when measured levels are within 0dB ±1dB. Therefore, small level differences can be easily measured).
- The level meter can serve as an amplifier. It also has DC output for recording purpose.
- Switching for determining gains and losses is easy to perform.
- Small in size, light in weight; compact design with ease of operation.

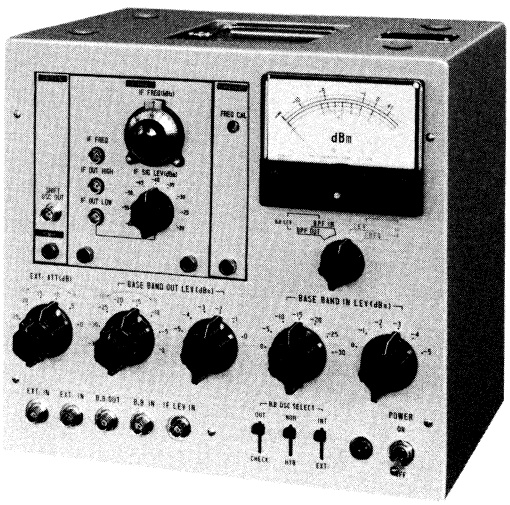
TYPE AH-4730D, TRANSMISSION MEASURING TEST SET

SPECIFICATIONS

<table>
<tr><td>Frequency range and impedance</td><td colspan="3">0.3 to 150 kHz, 600Ω balanced (connector used: I-214)
10 to 650 kHz, 150Ω balanced (connector used: I-214)
10 to 650 kHz, 75Ω balanced (connector used: I-214)
10 Hz to 30 MHz, 75Ω unbalanced (connector used: BNC)
Note:
The output frequency of the AJ-2730 synthesizer:
Basic range (front panel terminal): 10 Hz to 20 MHz.
Extension range (rear panel terminal): 20 to 30 MHz.</td></tr>
<tr><td rowspan="3">Measurement accuracy (10 Hz to 20 MHz)</td><td>Impedance</td><td>600/150/75Ω balanced</td><td>75Ω unbalanced</td></tr>
<tr><td>Input-side substitution measurement</td><td colspan="2">±0.15 dB, 0 to 30 dB
±0.3 dB, 0 to 75 dB</td></tr>
<tr><td>Output-side substitution measurement</td><td>±0.15 dB, 0 to 30 dB
±0.5 dB, 0 to-60 dB</td><td>±0.15 dB, 0 to 30 dB
±0.3 dB, 0 to 75 dB</td></tr>
<tr><td rowspan="2">Output level</td><td colspan="2">10 Hz to 20 MHz</td><td>20 to 30 MHz</td></tr>
<tr><td colspan="2">−50 to +15 dBm in 1 dB steps</td><td>Approx. −2 dBm</td></tr>
<tr><td rowspan="2">Level measurement range</td><td>Input A (10 Hz to 20 MHz)</td><td colspan="2">−70 to +22 dBm (including meter range)
−60 to +20 dBm (using attenuator dials)</td></tr>
<tr><td>Input B (10 Hz to 30 MHz)</td><td colspan="2">−70 to +2 dBm (including meter range)
−60 to 0 dBm (using attenuator dials)</td></tr>
<tr><td>Attenuation</td><td colspan="3">0 to 91 dB in 0.1 dB steps (switching unit attenuator section, three dials)</td></tr>
<tr><td>Power requirements</td><td colspan="3">100V AC, 50/60 Hz; approx. 50 VA</td></tr>
<tr><td>Dimensions & weight (in a stack)</td><td colspan="3">Approx. 330H x 350W x 250D mm; approx. 16 kg</td></tr>
<tr><td>Accessories supplied</td><td colspan="3">Measuring cables terminated on both ends with BNC connectors:
1.5 m long (two), 0.5 m long (four), 0.2 m long (one)
Measuring cables terminated on both ends with I-214 connectors:
1.5 m long (two), 0.5 m long (two), 0.1 m long (one)
U-links (three pieces)</td></tr>
</table>

TEST SETS
TYPES PMS-15A/15B

● *For detective relay system transmitter-receiver tests*



TYPE PMS-15B

The Test Set, Types PMS-15A and PMS-15B, is designed for routine maintenance and adjustment of a detective relay system transmitter-receiver for radio communications. Important measurements such as base band levels, IF output levels, IF frequency and frequency modulation degree* are easily made.

Type PMS-15A is provided with a shift oscillator unit for a loop-around test of a transmitter-receiver, while Type PMS-15B is not equipped with the shift oscillator.

Other units installed in the each test set are a base band level meter, a base band oscillator, an IF level meter, an IF oscillator, a two-signal synthetic circuit, etc.

*The frequency modulation degree can be checked by the indication of the dB meter on the front panel.

SPECIFICATIONS

MAIN UNIT

BASE BAND OSCILLATOR

Frequency:	200 kHz or 500 kHz (as specified).
Frequency accuracy:	Within $\pm 5 \times 10^{-3}$
Output level:	−40 to 0 dBm.
Output impedance:	75Ω unbalanced.

BASE BAND LEVEL METER

Frequency range:	1 kHz to 3.2 MHz.
Measurement range:	−35 to 0 dBm.
Frequency characteristics:	Deviation, within 0.5 dB with reference to input level of 0 dBm.
Input impedance:	75 Ω unbalanced.

IF LEVEL METER

Frequency:	70 MHz ± 5 MHz.
Measurement range:	−5 dBm ± 3 dBm (when using an external coaxial fixed pad: +1 dBm ± 3 dBm).
Frequency characteristics:	Within ±0.5 dB, referred to 70 MHz.
Input impedance:	75 Ω at 70 MHz, VSWR less than 1.2.

HYBRID ATTENUATOR CIRCUIT

Attenuation:	6 to 41 dB (6 dB coupling attenuation included).
Input/output impedance:	75Ω unbalanced.

IF FREQUENCY UNIT

Frequency:	70 MHz ±5 MHz.
Frequency accuracy:	Within ± 200 kHz.
Input sensitivity:	Less than −20 dBm with reference to indication of −5 dBm on the meter.
Output level of oscillator:	"HIGH" terminal: + 4 dBm (fixed). "LOW" terminal: −60 to −20 dBm (5 dB x 8).
Input/output impedance:	75Ω at 70 MHz, VSWR less than 1.2.

SHIFT OSCILLATOR UNIT (for Type PMS-15A)

Frequency:	Any one of 120, 130, 160, 161, 252.04 MHz (as specified).
Frequency accuracy:	Within $\pm 1 \times 10^{-3}$
Output level:	More than + 4 dBm.
Output impedance:	Approx. 75 Ω.

GENERAL

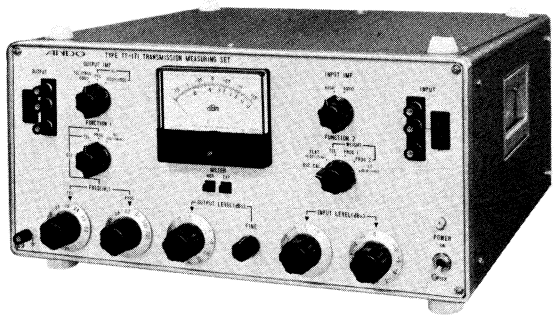
Power requirements:	100V AC, 50/60 Hz.
Dimensions:	Approx. 275 (H) x 300 (W) x 200 (D) mm.
Weight:	Type PMS-15A: Approx. 10.5 kg. Type PMS-15B: Approx. 10 kg.

TRANSMISSION MEASURING SETS

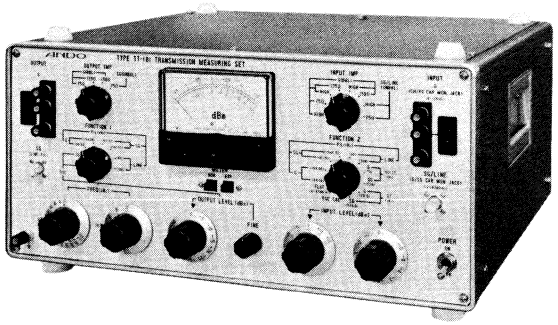
TT-170/180 SERIES

- *Ideal for transmission measurements on FDM systems*
- *Versatile*
- *Small & compact*
- *Easy-to-use*

The TT-170/180 series is a transmission characteristics measuring equipment best suited for use in the alignment and maintenance of frequency division multiplex (FDM) system terminal equipment.
It is composed of Type TT-170 series set for carrier system channel translating equipment and Type TT-180 series set for carrier system group, supergroup translating equipment in combination, and permits measuring of the transmission characteristics of the FDM system terminal equipment of up to 960 CH.



TYPE TT-171



TYPE TT-181

TT-170 Series

The TT-170 series includes the following three models: TT-170, TT-171, and TT-172.
These three models are classified mainly according to the characteristics of the weighted noise measurement network for program band.

FEATURES (TT-170 Series)

- Performs accurate transmission measurements on telephone band.
- Generates frequencies recommended by CCITT.
- OSC CAL function makes internal level calibration easy.
- Measures small level difference down to 0.1 dB.
- Provides white noise output for group band (60 to 108 kHz). Therefore, 12 CH pseudo-random signals can be obtained by giving this output to the receiving unit (R.IN) of a channel translating equipment (CH.TR).
- Attains weighted noise level measurements on telephone and program bands that comply with CCITT recommendation.
- Measures crosstalk up to 90 dB at 800 Hz (ground communication system) and 1kHz (satellite communication system).

TT-180 Series

The TT-180 series is available in three different models, TT-180, TT-181 and TT-182.
These three models are classified mainly in accordance with the difference in the pilot signal generation.

FEATURES (TT-180 Series)

- Accomplishes accurate transmission measurements on both group and supergroup bands.
- Generates frequencies at 4 kHz intervals for group band, and those at 48 kHz intervals for supergroup band.
- OSC CAL function makes internal level calibration easy.
- Measures small level difference down to 0.1 dB.
- Capable of sending and selecting group, supergroup and line pilots.
- Makes noise level measurements (unweighted) in operating circuits (70 kHz for group band; 534 kHz for supergroup band).
- Measures crosstalk up to 110 dB at 70.8 kHz (group band) and 534.8 kHz (supergroup band).
- Measures flat levels from CH carrier to FDM 960 CH system SG carrier.

TT-170 SERIES, TRANSMISSION MEASURING SETS

SPECIFICATIONS

Type				TT-170	TT-171	TT-172
Oscillator section	Output frequencies		Telephone band	0.2/0.3/0.4/0.6/0.8/1.0/2.4/3.0/3.4/3.6 kHz. 10 frequencies		
			Programme band	0.05/0.1/0.2/0.8/6.0/8.5 /10 kHz 7 frequencies	0.04/0.05/0.1/0.125/0.2/0.8/6.0/8.5/10.0/14.0/15.0 kHz. 11 frequencies	
			Accuracy	±0.2%		
			Stability	Accuracy is met at the temperature 0° to +45°C with line voltage variation of ±10%		
	Output impedance			600Ω balanced. Return loss, 20 dB or more.		
	Output level		Max. output level	+10 dBm		
			Adjustable range	−30 to +10 dBm in 5 dB steps. Fine control provided (continuously adjustable 5 dB or more).		
			Frequency response	±0.2 dB (typical at 1 kHz)		
			Stability	±0.3 dB at the temperature 0° to +45°C with line voltage variation of ±10%		
	Distortion			35 dB or more (typical at +10 dBm)		
White noise generator section	Continuous spectrum range			60 to 108 kHz		
	Frequency response			±1 dB		
	Max. output level			−10 dBm or more (60 to 108 kHz, band limit)		
	Output level range			−50 to −10 dBm in 5 dB steps. Fine control provided (continuously adjustable 5 dB or more).		
	Output impedance			75Ω/150Ω (135Ω) balanced		
Level meter section	Flat	Frequency range		0.05 to 15 kHz	0.03 to 15 kHz	
		Measurement range		−60 to +10 dBm (−70 to +12 dBm including meter range)		
		Frequency response		±0.3 dB, 0.05 to 15 kHz (typical at 1 kHz)	±0.3 dB, 0.05 to 15 kHz (typical at 1 kHz) ±0.5 dB, 0.03 to 15 kHz (typical at 1 kHz)	
	Weight	Frequency range		Telephone: 0.05 to 5 kHz (P53). Programme: 0.06 to 10 kHz (P53); 0.0315 to 31.5 kHz (J16)		
		Measurement range		−60 to +10 dBm (−70 to +12 dBm including meter range)		
		Frequency response	Telephone	Compatible with CCITT recommendation P53		
			Programme	CCITT P53	CCITT P53/J16	CCITT J16
	Crosstalk	Frequency range		0.8 to 1 kHz		
		Measurement range		−80 to −10 dBm (−90 to −8 dBm including meter range)		
		Band pass filter		1 dB or less, 0.8 to 1 kHz. 40 dB or more, 0.03 to 0.3 kHz and 4 to 15 kHz.		
	Level indication		Dial step	10 dB x 6, 1 dB x 10		
			Meter scale	Normal: −10 to +2 dBm. Expansion: ±1.5 dBm (the smallest division 0.1 dBm)		
	Level measurement accuracy		Dial step accuracy	±0.2 dB, relative error for 0 dBm (at 1 kHz flat measurement)		
			Meter scale accuracy	±0.3 dB, −5 to +2 dBm. ±0.5 dBm, −10 to −5 dBm.		
	Level indication stability			±0.5 dB at the temperature 0° to +45°C with line voltage variation of ±10%		
	Input impedance			600Ω/high, balanced. Return loss: 20 dB or more.		
Power requirements				Selectable: 100/110/115/117/120/127/200/220/230/240V AC, 50/60 Hz.		
Power consumption				Approx. 15 VA.		
Dimensions & weight				Approx. 200(H) x 425(W) x 350(D) mm, approx. 12 kg.		
Accessories supplied				Two (2m long) measuring cables (one terminated on both ends with M-1PS connectors, the other terminated on both ends with I-214 APS connectors). Three fuses.		
Options				Portable carrying case constructed of alminum with padding for protection during transit (can accomodate two sets of the instruments and accessories).		

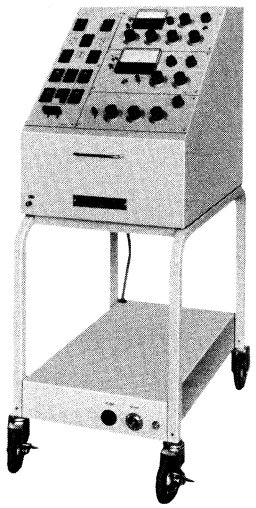
TT-180 SERIES, TRANSMISSION MEASURING SETS

SPECIFICATIONS

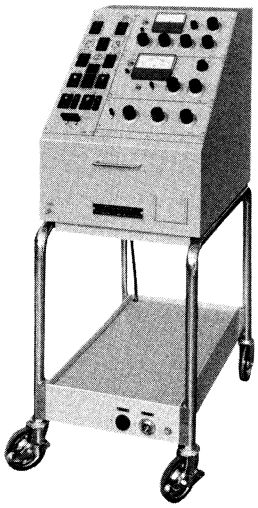
Type				TT-180	TT-181	TT-182
Oscillation section	Output frequencies		Group band	60.6/64/68/72/76/80/84/88/92/96/100/103.7/104/104.6/107.7 kHz and 70.8 kHz (70.8 kHz for crosstalk measurement). 16 frequencies.		
			Supergroup band	312.3/360/408/456/504/551.4 kHz and 534.8 kHz (534.8 kHz for crosstalk measurement). 7 frequencies.		
	Output frequency accuracy			±25 Hz		
	Output frequency stability			Accuracy is met at the temperature 0° to +45°C with ±10% line voltage variation.		
	Output impedances		Group band	75/135/150Ω, balanced. Return loss, 20 dB or more.		
			Supergroup band	75Ω unbalanced. Return loss, 20 dB or more.		
	Output level		Max. output level	0 dBm		
			Adjustable range	−50 to 0 dBm. Fine control provided (continuously adjustable 5 dB or more).		
			Frequency response	±0.2 dB		
			Stability	±0.3 dB at the temperature 0° to +45°C with ±10% line voltage variation.		
	Distortion			35 dB or more (typical at 0 dBm)		
Pilot oscillator section	Output frequencies		Group pilot	84.08 kHz	84.08 kHz and 104.08 kHz	104.08 kHz
			Supergroup pilot	411.92 kHz	411.92 kHz and 547.92 kHz	547.92 kHz
			Line pilot	60 kHz or 308 kHz (as specified)	60 kHz and 308 kHz	60 kHz or 308 kHz (as specified)
	Frequency accuracy			±3 Hz		
	Frequency stability			Accuracy is met at the temperature 0° to +45°C with ±10% line voltage variation.		
	Output level		Group pilot	−9 dBm ±5 dB (internal setting)		
			Supergroup pilot	−40 dBm ±5 dB (internal setting)		
			Line pilot	−10 dBm ±5 dB or −40 dBm ±5 dB (internal setting)		
	Output impedances		Group band	75/135/150Ω balanced. Return loss, 20 dB or more.		
			Supergroup band	75Ω unbalanced. Return loss, 20 dB or more.		
	Distortion			35 dB or more		
Level meter section	Flat	Freq. range	Group	4 to 120 kHz (group band, 60 to 108 kHz; CH carrier, 12 to 20 kHz; PG carrier, 84 to 120 kHz)		
			Supergroup & line	12 to 4340 kHz (supergroup band, 312 to 552 kHz; G carrier, 420 to 612 kHz; SG carrier, 612 to 4340 kHz)		
		Measurement range		−60 to +20 dBm (−70 to +22 dBm including meter range)		
		Freq. response	Group	± 0.3 dB (typical at 84 kHz)		
			Supergroup & line	± 0.3 dB (typical at 456 kHz)		
	Pilot	Measurement range		−60 to +20 dBm (−70 to +22 dBm including meter range)		
		Filter	Group pilot	Pass band: ±0.2 dB at f_0 ±7 Hz. Attenuation band: 40 dB or more at f_0 < −380 Hz, > +70 Hz.		
			Supergroup pilot	Pass band: ±0.2 dB at f_0 ±7 Hz. Attenuation band: 40 dB or more at f_0 < −70 Hz, > +380 Hz.		
			Line pilot	——	Same as above	——
	Noise	Freq.	Group	1 CH (unweighted) at double sideband with 70 kHz center frequency		
			Supergroup	1 CH (unweighted) at double sideband with 534 kHz center frequency		
		Measurement range		−100 to −20 dBm (−110 to −18 dBm including meter range)		
	Crosstalk	Freq.	Group	70.8 kHz		
			Supergroup	534.8 kHz		
		Measurement range		−100 to −20 dBm (−110 to −18 dBm including meter range)		
	Level indication		Dial step	10 dB x 7, 1 dB x 10		
			Meter scale	Normal: −10 to +2 dBm. Expansion: ±1.5 dBm (the smallest division 0.1 dBm)		
	Level measurement accuracy		Dial step accuracy	±0.3 dB, relative error for 0 dB (at 456 kHz flat measurement)		
			Meter scale accuracy	±0.3 dB, −5 to +2 dBm. ±0.5 dB, −10 to −5 dBm		
	Level indication stability			±0.5 dB at the temperature 0° to 45°C with ±10% line voltage variation (flat level)		
	Input impedances		Group band	75, 135, 150Ω/high, balanced. Return loss, 20 dB or more.		
			Supergroup band	75Ω/high, unbalanced. Return loss, 20 dB or more		
Power requirements				Selectable: AC 100/110/115/117/120/127/200/220/230/240 V, 50/60 Hz; Approx. 40 VA		
Dimensions & weight				Approx. 200(H) x 425(W) x 350(D) mm. Approx. 15 kg		
Accessories supplied				Four (2m long) cables, one probe, two adapters, three fuses.		
Options				Portable carrying case (can accomodate two sets of the instruments and accessories)		

TRANSMISSION MEASURING TEST SETS

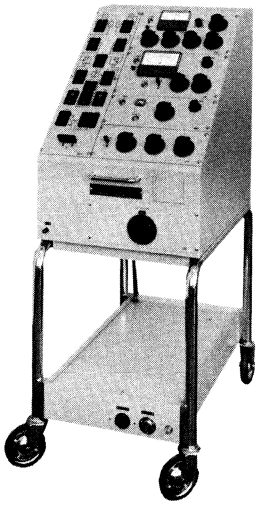
TYPES VST-261/262/251B/252B/253B



TYPE VST-251B



TYPE VST-261



TYPE VST-262

Types VST-251B, VST-252B, VST-253B are for installation in terminal stations and master repeater stations for the maintenance of basic groups of coaxial and micro supermultiplex systems, etc. These VST-251B, 252B, 253B differ in pilot monitor frequencies from one another.

Type VST-261 is intended for the maintenance of program relaying system and toll dialing switching system.
Type VST-262 is intended for the maintenance of carrier wave telegraph lines and equipment.

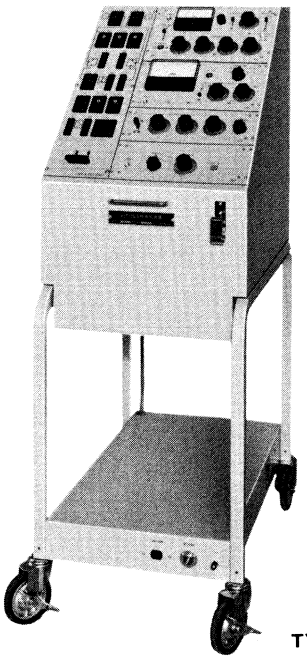
SPECIFICATIONS

Type		VST-261	VST-262	VST-251B, -252B, -253B
Level measurement	Frequency range	30 Hz to 10 kHz		0.3 to 150 kHz
	Measuring range	−60 to +25 dBm	−90 to +25 dBm	−60 to +20 dBm
	Accuracy	Within ±0.3 dB		Within ±0.3 dB, 0.3 to 30 kHz Within ±0.5 dB, 5 to 150 kHz
	Input impedance	600Ω (balanced) and high		600Ω (balanced) and high, 0.3 to 30 kHz 75Ω (balanced) and high, 5 to 150 kHz
Gain & loss measurement	Frequency range	30 Hz to 10 kHz	0.2 to 10 kHz	0.3 to 130 kHz
	Measuring range	0 to 65 dB	0 to 80 dB	0 to 75 dB
	Accuracy	Within ±0.3 dB		Within ±0.3 dB, 0.3 to 30 kHz Within ±0.5 dB, 5 to 130 kHz
	Line impedance	600Ω (balanced)		600Ω (balanced), 0.3 to 30 kHz 75Ω (balanced), 5 to 130 kHz
Crosstalk measurement	Frequency range	———		0.3 to 130 kHz
	Measuring range	———		0 to 75 dB
	Accuracy	———		Within ±0.3 dB, 0.3 to 30 kHz Within ±0.5 dB, 5 to 130 kHz
	Line impedance	———		600Ω (balanced), 0.3 to 30 kHz 75Ω (balanced), 5 to 130 kHz
Pilot monitor frequencies selected		———		VST-251B: 60 kHz, 72 kHz VST-252B: 54 kHz, 60 kHz VST-253B: Flat
Power requirements		100V AC, 50/60Hz; −21V DC		100V AC, 50/60Hz; −21V DC
Power consumption		Approx. 4VA		Approx. 4VA
Dimensions (with a trolley)		Approx. 1100(H)x400(W)x620(D)mm		Approx. 1100(H)x400(W)x620(D)mm
Weight		Approx. 60 kg		Approx. 56 kg

TRANSMISSION MEASURING TEST SETS

TYPES VST-20B (300 Hz to 2.1 MHz)/24 (50 kHz to 7 MHz)

TYPE VST-20B



TYPE VST-20B

The VST-20B measures level, gain, loss and crosstalk on carrier systems. It consists of an oscillator, a level meter, an attenuator, and a patching panel which has a built-in weighting network for telephone (psophometric, CCITT P53).

SPECIFICATIONS

Level measurement:
- Frequency range: 300 Hz to 2.1 MHz.
- Measuring range: −60 to +25 dBm.
- Measuring accuracy: ±0.3 dB for 0.3 to 60 kHz. ±0.5 dB for 30 kHz to 2.1 MHz.
- Input impedance: 600Ω balanced for 0.3 to 150 kHz. 75Ω balanced for 30 kHz to 2.1 MHz.

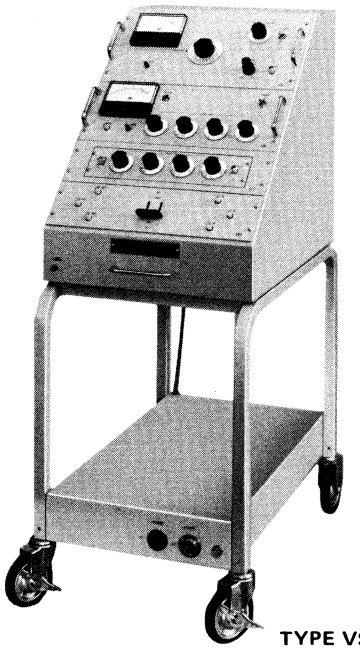
Gain and loss measurements:
- Frequency range: 300 Hz to 2.1 MHz.
- Measuring range: 0 to 80 dB.
- Measuring accuracy: ±0.5 dB for 10 kHz and 500 kHz, and attenuation 80 dB.
- Line impedance: 600Ω balanced, 0.3 to 150 kHz. 75Ω balanced, 30 kHz to 2.1 MHz.

Crosstalk measurement:
- Frequency range: 300 Hz to 2.1 MHz.
- Measuring range: 0 to 70 dB.
- Measuring accuracy: ±0.5 dB for 10 kHz and 500 kHz, and crosstalk 70 dB.
- Line impedance: Same as gain and loss measurements.

Power requirements: 100V AC, 50/60 Hz; approx. 18VA.

Dimensions & weight: Approx. 1195(H)x400(W)x620(D) mm (with a trolley); approx. 60 kg.

TYPE VST-24



TYPE VST-24

This equipment is a transmission test trolley suitable for measuring gain, loss and level on coaxial carrier systems. It also has the capability to examine AGC (automtic gain control) performance in the system. It consists of an oscillator, a level meter, an attenuator and a patching panel.

SPECIFICATIONS

Level measurement:
- Frequency range: 50 kHz to 7 MHz.
- Measuring range: −65 to +15 dBm.
- Measuring accuracy: ±0.5 dB.
- Input impedance: 75Ω unbalanced.

Gain and loss measurements:
- Frequency: 60 to 4092 kHz (18 frequencies): 60, 308, 556, 808, 1056, 1304, 1552, 1800, 2048, 2296, 2544, 2792, 3040, 3288, 3536, 3784, 4092, 420 kHz.
- Measuring range: 0 to 70 dB.
- Measuring accuracy: ±0.5 dB.
- Line impedance: 75Ω unbalanced.

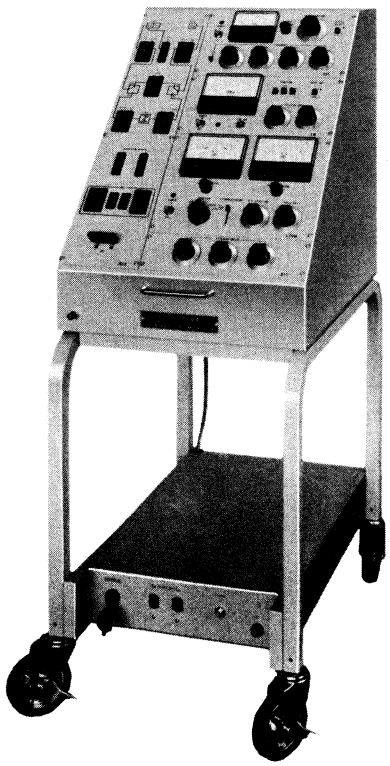
AGC test:
- Frequency: 60 kHz, 4092 kHz.
- Sending level: −30, −20, +5 dBm.
- Line impedance: 75Ω unbalanced.

Power requirements: 100V AC, 50/60 Hz. −21V DC; approx. 5VA.

Dimensions: Approx. 1100 (H) x 400 (W) x 620 (D) mm. (with a trolley)

Weight: Approx. 70 kg.

TRANSMISSION MEASURING TEST SET
TYPE AH-4431



The AH-4431 Transmission Measuring Test Set is intended for use in maintenance and construction of a broadcasting relay system of 15kHz band stereo signals (or monaural signals), and is suitable for measuring the transmission characteristics such as noise characteristics, attenuation distortion characteristics, and interstereo channel characteristics. It is of trolley type and consists of a jack panel, an oscillator panel, a level meter panel, a level-difference/phase-difference measurement panel and an attenuator panel.

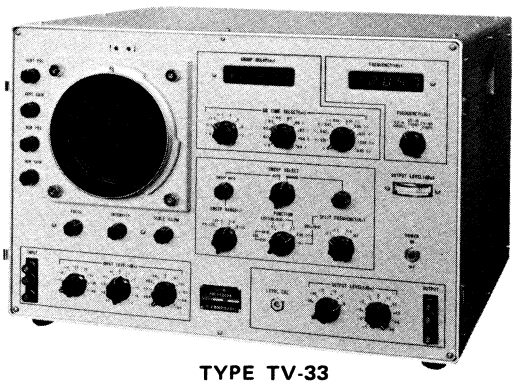
SPECIFICATIONS

Level measurement:	
Measuring range:	-70 to +20dBm
Frequency range:	0.03 to 15kHz at 600Ω
Gain measurement:	
Measuring range:	0 to 70dB
Frequency range:	0.03 to 15kHz at 600Ω
Loss measurement:	
Measuring range:	0 to 70dB
Frequency range:	0.03 to 15kHz at 600Ω
Input impedance:	600Ω balanced, high impedance (LM IN jack)
Power requirements :	100V ±10% AC, 50/60Hz
Dimensions:	Approx. 1100(H) x 400(W) x 620(D) mm
Weight:	Approx. 54kg

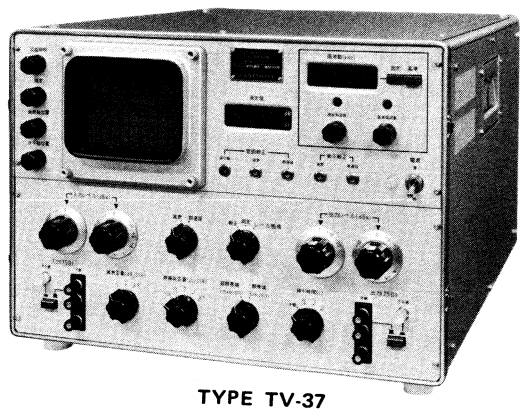
TRANSMISSION CHARACTERISTICS CURVE TRACERS

TYPES TV-33/37

The TV-37 measures the group delay and amplitude characteristics of waveforms in transmission lines of group and supergroup bands by tracing them on a CRT display.
The group delay and amplitude characteristics measurements are required in order to examine the effects on the quality of the waveforms produced by the transmission characteristics. The digital memory employed facilitates the trace viewing even at a low speed sweep. This is also convenient for trace recordings by a camera.
The TV-33 measures the group delay and amplitude characteristics of waveforms in data transmission lines.
Like the TV-37, the TV-33 gives a direct viewing measurement by using a CRT display. The set features a far-end measurement (by using an optional converter), absolute measurements of group delay time and input level, digital readout of output frequency, and a recorder output. A trace recording may be possible by using a camera.



TYPE TV-33



TYPE TV-37

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SPECIFICATIONS

Type	TV-33	TV-37
Frequency range	0.2 to 4 kHz (600Ω) 0.5 to 10 kHz (110Ω) 2.5 to 50 kHz (110Ω)	60 to 110 kHz (75Ω balanced) 310 to 560 kHz (75Ω unbalanced)
Input/output impedance	600Ω and 110Ω balanced	75Ω balanced 75Ω unbalanced
Output level	−30 to +5 dBm in 1 dB steps	−30 to 0 dBm in 1 dB steps
Input level	−45 to +5 dBm in 0.1 dB steps	−30 to 0 dBm in 1 dB steps
Amplitude characteristics measurement	0.5, 2.5 dB/div.	CRT: 0.5, 1, 2 dB/div. Digital readout: ±2 to 8 dB/full-scale
Group delay characteristics measurement	0.05, 0.1 msec./div.	CRT: 0.5, 1, 5, 10, 20 μsec./div. Digital readout: ±2 to 80 μsec./full-scale
Group delay modulation frequency	14.3, 28.6, 71.4, 357 Hz	416.66 Hz
Marker frequency	0.3, 1.5, 3.4 kHz (0.2 to 4 kHz) 0.6, 2.4, 9.6 kHz (0.5 to 10 kHz) 3.0, 12, 48 kHz (2.5 to 50 kHz)	———
Sweep rate	0.5 to 1.25 sec., 1.25 to 3 sec. 3 to 8 sec., 8 to 20 sec.	5, 10, 20 sec.
Sweep mode	Auto & manual	Auto & manual
Power requirements	100V AC, 50/60 Hz; approx. 160 VA	100V AC, 50/60 Hz; approx. 98 VA
Dimensions (H x W x D)	Approx. 350 x 520 x 550 mm (with front panel cover)	Approx. 300 x 425 x 485 mm (with front panel cover)
Weight	Approx. 37 kg	Approx. 28 kg

PSOPHOMETERS

Noise Measurement

A psophometer (noise measuring set) is used in the measurement of voice band noise level that produced in communication lines and other transmission circuits.

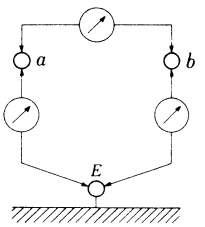
The level of noise that disturbs the human ear varies with the waveform of noise, its duration, receiver characteristics, and other factors.

The CCITT recommends the psophometric criteria for evaluation of speech quality and transmission performance of commercial telephone lines and broadcasting circuits based on the electroacoustic characteristics and the average sensitivity of human ears.

An equalizer which has the frequency response of the weighting network based on the CCITT recommendations is combined with a level meter to form a psophometer.

As the noise measuring set is intended for use in the measurement in voice circuits, the input impedances are 600Ω balanced and HIGH. The level is measured in 1 mW (0 dBm) units and indicated in dBm.

The input circuit incorporates a capacitor which intercepts DC so that the noise level is measured accurately even in the exchange and power supply systems where AC and DC currents are superimposed each other. Accordingly, the level of noise across two balanced lines (a and b in the figure) and across one of balanced lines and ground (across a and E or across b and E) can also be measured.



Noise Measurement across Two Balanced Lines or across One of Balanced Lines and Ground

Usable as a Flat Level Meter

The Ando's psophometers can be served as flat level meters for voice band measurement by front panel switch selection.

The signal levels are indicated in rms values. Recorder output is obtainable.

Frequency (Hz)	Response (dB)	Tolerance (dB)
50	-63.0	±2
100	-41.0	±2
150	-29.0	±2
200	-21.0	±2
300	-10.6	±1
400	-6.3	±1
500	-3.6	±1
600	-2.0	±1
800	0	0
1000	+1.0	±1
1200	0	±1
1500	-1.3	±1
2000	-3.0	±1
2500	-4.2	±1
3000	-5.6	±1
3500	-8.5	±2
4000	-15.0	±3
5000	-36.0	±3

Table 1. Frequency Response of the Weighting Network on a Telephone Circuit (CCITT P53)

Frequency (Hz)	Response (dB)	Tolerance (dB)
60	-32.2	±1.5
100	-26.1	±1.5
200	-17.3	±1.5
300	-12.5	±1.5
400	-8.8	±1.5
800	-1.9	±1.5
1000	0	0
2000	+5.3	±1.5
4000	+8.2	±1.5
5000	+8.4	±1.5
6000	+8.2	±1.5
7000	+7.3	±1.5
8000	+5.1	±1.5
9000	-0.3	±3.0
10000	-9.7	±3.0

Table 2. Frequency Response of the Weighting Network on a Programme Circuit (PROG 1) (CCITT P53)

Frequency (Hz)	Response (dB)	Tolerance (dB)
31.5	-29.9	±2.0
63	-23.9	±1.4
100	-19.8	±1.0
200	-13.8	±0.85
400	-7.8	±0.7
800	-1.9	±0.55
1000	0	±0.5
2000	+5.6	±0.5
3150	+9.0	±0.5
4000	+10.5	±0.5
5000	+11.7	±0.5
6300	+12.2	0
7100	+12.0	±0.2
8000	+11.4	±0.4
9000	+10.1	±0.6
10000	+8.1	±0.8
12500	0	±1.2
14000	-5.3	±1.4
16000	-11.7	±1.65
20000	-22.2	±2.0
31500	-42.7	$+2.8_{-\infty}$

Table 3. Frequency Response of the Weighting Network on a Programme Circuit (PROG 2) (CCITT J16)

PSOPHOMETER
TYPE NM-36

The NM-36 is a portable noise meter designed for: measuring noises induced or produced in telephone circuits, programme circuits, telephone sets, etc. or measuring those caused by communication equipment.
It can perform weighted noise measurements in accordance with CCITT recommendations: the weighting networks on telephone circuits (P.53) and programme circuits (P.53, J.16).
The measurement is made in terms of rms value. The NM-36 can also serve as a flat level meter.

● *Performs weighted noise measurements on telephone and programme circuits*

FEATURES

- Weighting networks that comply with CCITT requirements
- Small in size, light in weight; housed in a portable carrying case
- Recorder and monitoring outputs

SPECIFICATIONS

Frequency range:
Flat level meter: 0.03 to 15 kHz.
Telephone circuit: 0.05 to 5 kHz.
Programme circuit (PROG 1): 0.06 to 10 kHz.
Programme circuit (PROG 2): 0.0315 to 31.5 kHz.
Input impedance: More than 10 kΩ, or 600Ω ±1%.
Measurement range: +27 to -80dBm (with indicating meter range).
Frequency response:
Flat (referred to 1kHz): ±1dB (30 Hz to 100 Hz), ±0.5dB (100 Hz to 10 kHz), ±1dB (10 to 15 kHz).
Weighting: As shown in Tables 1, 2, 3. (Page 124)
Measurement accuracy:
Attenuator step accuracy: ±0.5dB (relative error for 0dB).
Indicating meter scale accuracy: ±0.5dB (+2 to -5dBm), ±1dB (-5 to -10dBm).
Indicated level stability (±10% line voltage variation): ±0.5dB (20°C ±15°C), ±0.7dB (20°C ±20°C).
Recorder output: Approx. 50mV, 100kΩ load (when the meter indication is at 0dBm).
Monitoring output: More than -10dBm, 600Ω load (when the meter indication is at 0dBm).
Power requirements (selectable by using the rear panel slide switch): 100–120V/200–240V AC, 50/60 Hz
Dimensions: Approx. 150(H) x 280(W) x 155(D) mm.
Weight: Approx. 4 kg.

PSOPHOMETER

TYPE AD-9430

- *Specially designed for use in psophometric noise measurements of telephone and programme circuits*

Type AD-9430 Psophometer is designed for use in measurements of voice band noise which is induced or produced in telephone and other circuits as well as in various kinds of equipment. Its weighting networks comply with the CCITT recommendation (P53) concerning the psophometer characteristics telephone circuit noise measurement. It is capable of making accurate measurements of levels of noise which is produced in communications circuits.
Not only noise but also signal levels can be measured with high efficiency when the AD-9430 is operated in conjunction with its complementary plug-in units offered as options, such as programme circuits (CCITT P53, J16), channel filters (0.3 to 3.4 kHz), band pass filters, and so on.

AD-9430 Psophometer in combination with AH-4730D Transmission Measuring Set

FEATURES

- Incorporates CCITT weighting networks for telephone circuits.
- The measurement range is as wide as −90 to +22 dBm.
- An easy-to-read large dBm meter is employed.
- As the meter response time is adjustable, it is possible to average noise levels.
- Recorder and monitoring outputs are provided.
- The AD-9430 is designed flat-packed so that it is stable and easy to use.
- The AD-9430 is so designed as to be stacked up on the AH-4730D Transmission Measuring Set (see photo).
- Multi-purpose measurements (such as noise, signal and crosstalk) can be made by the use of optional plug-in units.

TYPE AD-9430, PSOPHOMETER

SPECIFICATIONS

Frequency range	Flat level (FLAT): 0.03 to 16 kHz Telephone circuit (TEL): 0.05 to 5 kHz
Input impedance	600 Ω and HIGH (more than 10 kΩ)
Measurement range	-90 to +22 dBm (including meter scale) -80 to +20 dBm (on a dial indication basis)
Frequency response	Flat (800 Hz reference): Within ±0.5 dB, 50 Hz to 21.5 kHz, Within +0.5 to -3 dB, 30 Hz to 16 kHz Weighting: Conforms to CCITT recommendation P53 for telephone circuits (TEL).
Measurement accuracy	Attenuator step accuracy: Within ±0.2 dB (relative to 0 dB) Meter reading accuracy: Within ±0.2 dB, -2 to +2 dBm Within ±0.5 dB, -6 to -2 dBm Within ±1 dB, -10 to -6 dBm
Indication stability	Within ±0.5 dB at line voltage ±10% and ambient temperature of 20°C±15°C Within ±0.7 dB at line voltage ±10% and ambient temperature of 20°C±20°C
Recorder output	Approx. 1 V into 100 kΩ (at 0 dBm meter indication)
Monitoring output	With -10 dBm ±1 dB into 600 Ω (at 0 dBm meter indication)
Power requirements	100 V AC, 50/60 Hz; approx. 4.5 VA
Dimensions	Approx. 100 (H) x 350 (W) x 250 (D) mm
Weight	Approx. 5 kg
Accessories supplied	One 2 m long cable

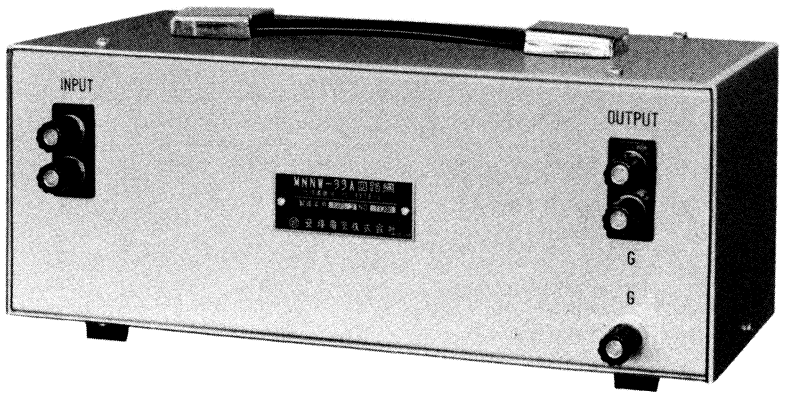
PLUG-IN UNITS (Options)

Model	Name of Unit	Specifications
PROG (P53)	Weighting Network for Programme Circuits	Conforms to CCITT recommendation P53.
PROG (J16)	Weighting Network for High-quality Programme Circuits	Conforms to CCITT recommendation J16.
VF-BPF	Voice Frequency Bandpass Filter	Pass band frequency response Less than 1 dB (0.4 to 2.5 kHz) Less than 3 dB (0.3 to 3.4 kHz) Attenuation band frequency response More than 45 dB (50 to 100 Hz) More than 40 dB (5 to 16 kHz)
800Hz-BPF	800 Hz Bandpass Filter	Pass band frequency response Less than 3 dB (800 Hz ±55 Hz) Attenuation band frequency response More than 40 dB (50 to 400 Hz, 1.6 to 10 kHz)
1 kHz-BPF	1 kHz Bandpass Filter	Pass band frequency response Less than 3 dB (1 kHz ±70 Hz) Attenuation band frequency response More than 40 dB (50 to 500 Hz, 2 to 10 kHz)

PLUG-IN UNIT (1 kHz bandpass filter)

TELEPHONE LINE WEIGHTING NETWORK

TYPE NW-1



The NW-1 is a network with the weighting characteristics for telephone line noise measurements and can determine noise in a telephone line by using as a pre-circuit of a flat level meter.

SPECIFICATIONS

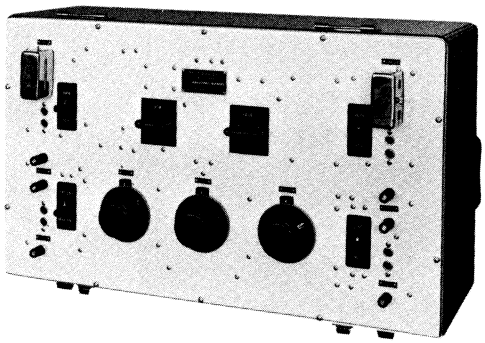
Frequency range: 50Hz to 5000Hz

Weighting characteristics & tolerance: For a telephone circuit in accordance with CCITT recommendation (P. 53). Constant loss: 5dB

Frequency (Hz)	Loss (dB)	Tolerance (dB)
50	68.0	±4
100	46.0	±2
150	34.0	±2
200	26.0	±2
300	15.6	±1
400	11.3	±1
500	8.6	±1
600	7.0	±1
800	5.0	±1
1000	4.0	±1
1200	5.0	±1
1500	6.3	±1
2000	8.0	±1
2500	9.2	±1
3000	10.6	±2
3500	13.5	±3
4000	20.0	±3
5000	41.0	±3

Input impedance: 600Ω balanced
Max. input level: 0dBm
Dimensions: Approx. 95(H) x 250(W) x 100(D) mm
Weight: Approx. 3.3kg

CROSSTALK MEASURING SET
TYPE PX-1



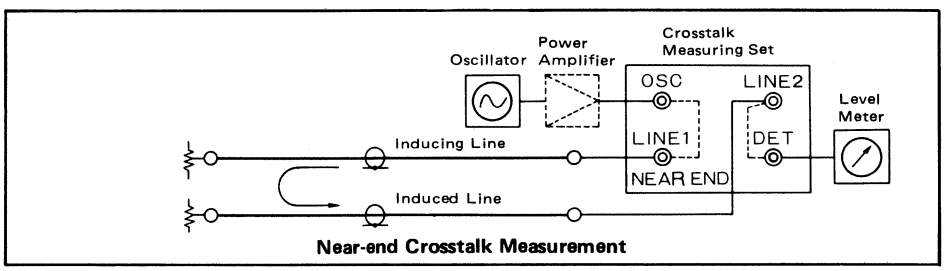
Transmission may crosscouple from one channel (inducing channel) to the other (induced channel) due to current-induced magnetic coupling of circuits or voltage-induced electrostatic coupling of circuits. This transmission cross-coupling may increase to such an extent that the messages of the induced channel are confused. This disturbance is called crosstalk.

When a voltage and a current which are induced in the inducing channel crosscouple to the induced channel, they are transmitted to both the sending and receiving ends. The voltage induced on the sending end is called near-end crosstalk and that induced on the receiving end is called far-end crosstalk.

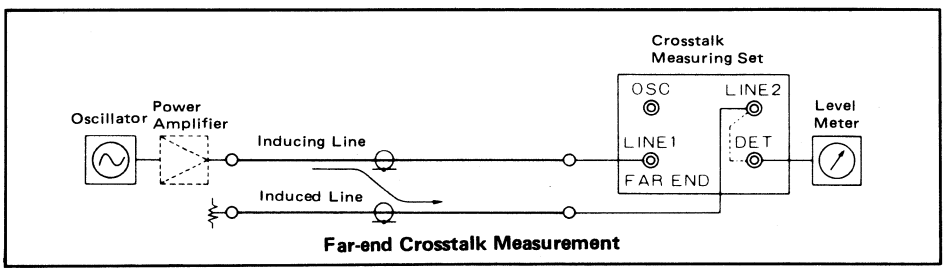
SPECIFICATIONS

Frequency range:	1 kHz to 150 kHz.
Measurements performed:	Near-end and far-end crosstalk measurements.
Measurement range:	0 to 150 dB in 0.1 dB steps.
Line impedance:	120, 150, 200, 300, 600Ω balanced.
Measurement accuracy:	From 0 to 100 dB crosstalk: ±1 dB, 1 kHz to 50 kHz. ±2 dB, 1 kHz to 150 kHz. From 0 to 150 dB crosstalk: ±2 dB, 1 kHz to 50 kHz. ±3 dB, 1 kHz to 150 kHz.
Maximum input level:	1 W (input side)
Input impedance for signal source:	600Ω balanced.
Output impedance for detector:	600Ω balanced.
Dimensions:	Approx. 350(H) x 590(W) x 250(D) mm (with front panel cover).
Weight:	Approx. 12 kg.
Companion instruments recommended:	TCO-48 Oscillator, ED-9 Detector-amplifier, TA-15B Amplifier.

(A matching transformer must be used for measuring a circuit with any impedance other than 600Ω. Terminal resistance for this purpose are required.)



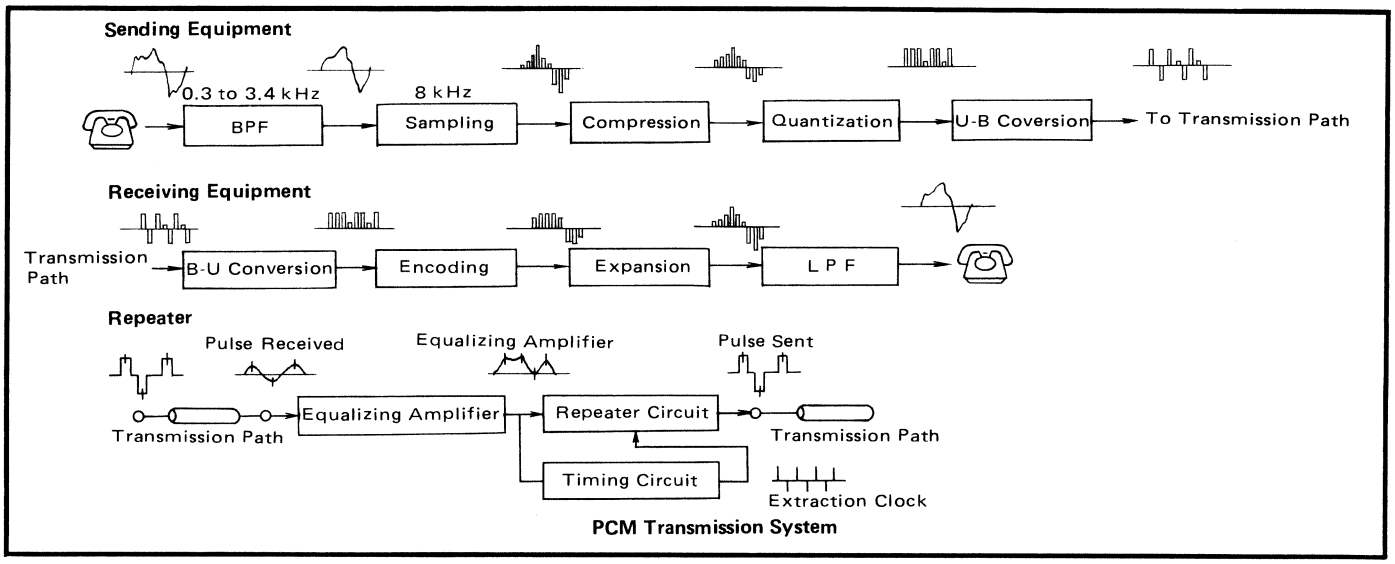
Near-end Crosstalk Measurement



Far-end Crosstalk Measurement

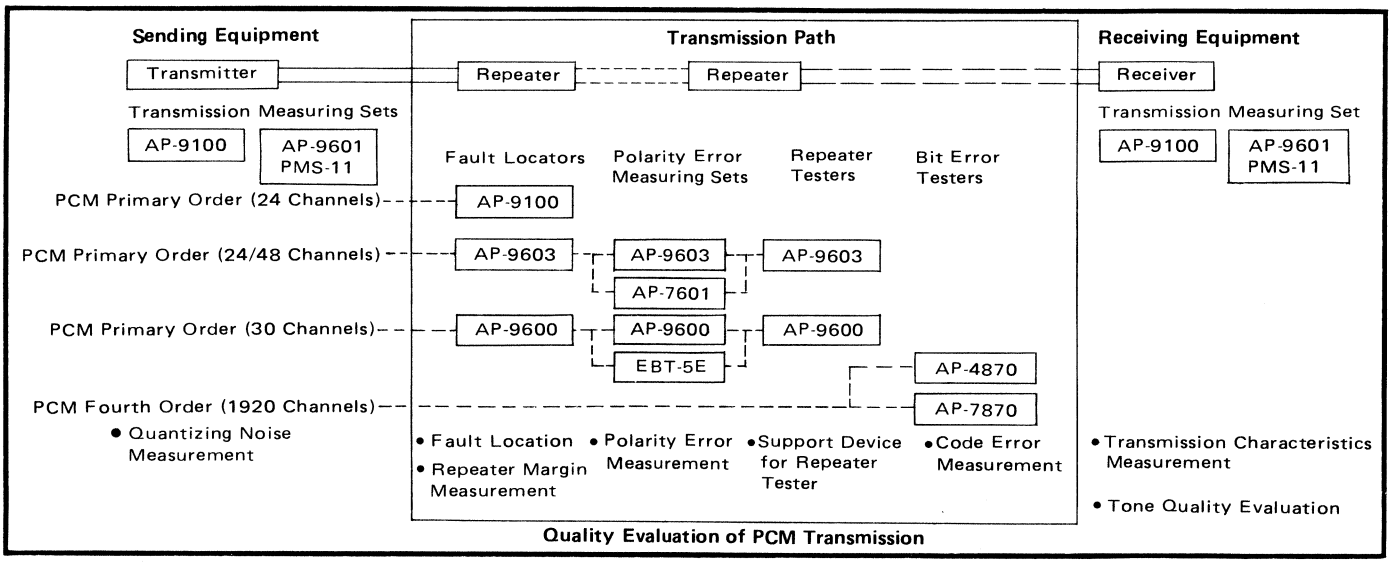
10 PCM TRANSMISSION MEASURING SETS

GENERAL INFORMATION



PCM Transmission System

Pulse code modulation (PCM) is a form of time-division multiplexing (TDM). PCM transmission system transmits voice, picture and data signals which are converted to pulse codes. On a sending section, signals go through the processes of sampling, multiplexing, compression, quantizing, and encoding to be converted to pulse codes, and on a receiving section, these processes go through in reverse order to be demodulated to the original signals. In a transmission channel, bipolar pulse codes are used and repeated by repeaters inserted in a transmission path at certain spans. In multiplexing with PCM, two systems are typical: PCM-24 and PCM-30. The PCM-24 system has 24 channels, while the PCM-30 system has 30 channels.



Quality Evaluation of PCM Transmission

Various noises are produced in the PCM transmission; quantizing noise, repeater thermal noise, crosstalk, power supply noise, and code interference. These noises combine to code, polarity and other errors. Accordingly it is necessary to check and make transmission measurements on the end equipment and repeaters at line installation and maintenance. Ando's PCM transmission measuring sets which are suitable for such checks and measurements are listed here.

A Quality Evaluation of the Multiplex Equipment

A-1 Quality Evaluation of the Sending Equipment

Noises which are peculiar to the PCM system and differ from those of the FDM system are produced at the PCM system multiplex equipment. These noises must be reduced below a certain level.

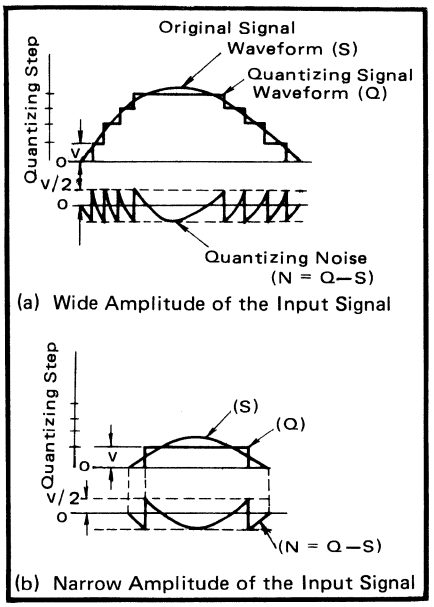
- Sampling Noise
  The sampling noise is an 8 kHz frequency component at a low level, and it is eliminated by the low-pass filter at the receiver.
- Quantizing Noise
  The noise which is produced at processes of quantizing and encoding.
- Idle Channel Noise
  On an idle channel, small noise received at the input and crosstalk from other channels.

Measurement of Quantizing Noise

Quantizing noise is measured in two ways: in one way a sine wave signal is used as the test signal and in the other a pseudo-random signal is used.

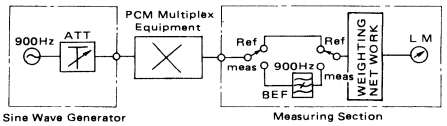
Quantizing is a process of converting a continuously changing voice amplitude to a discontinuous staircase waveform. Since the quantized signal is an approximation to the original signal, they differ from each other. This difference between the original signal and the quantized signal is called quantizing noise.

To be coded, a continuous signal must be quantized into discrete steps of amplitude and the discrete steps are rounded. As a result, the step differences give rise to quantizing noise. In this case, a low amplitude input signal affects seriously S/N ratio.



Use of the Sine Wave

A sine wave signal is applied to the transmitter of the PCM multiplex equipment and noise is measured at the receiver. The receiving end may be a standard receiving equipment or the receiver of the PCM multiplex equipment.



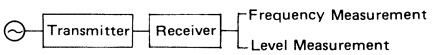
- In order to prevent beats, a frequency which is not an integral fraction of the sampling frequency (8 kHz) should be selected as the frequency of the input sine wave.
- As the greater part of noises at the receiver are accounted for quantizing noise, only eliminating the signal by a filter (BEF), all the remaining frequency components are measured as noise.

A-2 Quality Evaluation at the Receiving Equipment

At the receiving equipment it is checked whether the received

PCM signal is demodulated exactly to the original signal.

To make this check the measuring instruments used in the FDM system are required.



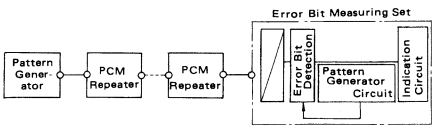
The signal for use in the measurement is coded by the transmitter of the sending multiplex equipment. To make accurate measurements, it is necessary to use a standard sending multiplex equipment.

B Quality Evaluation of the Digital Transmission Line

B-1 Code Error Measurement

In digital transmissions like PCM and data transmissions, even a single bit error in the code will appear as an erroneous message. Accordingly, the digital error rate is the most strict and appropriate measure for the reliability of the transmission line. The code error rate is calculated by the equation indicated below. In the PCM primary order, code error rates below 10^{-6} are considered desirable.

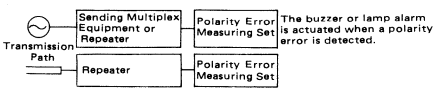
$$\text{Code error rate} = \frac{\text{Number of erroneous bits received}}{\text{Total number of bits sent}}$$



A particular pattern which is generated by the pattern generator is applied to the repeaters and received by the error bit measuring set. The error bit measuring set generates the same pattern as the pattern generator does and checks the one pattern against the other bit by bit in order to detect digital error.

B-2 Polarity Error Measurement

The polarity error measurement is made in order to detect an irregularity in polarity reversing. The method of polarity error measurement utilizes the phenomenon that the polarity of the code is reversed if it contains an error. Since this method is an approximation, errors are unavoidable. However, an adequate accuracy can be expected if the errors are not concentrated but dispersed. Since the measuring circuit is simple to construct and the measuring instrument can be made compact in design, this method of polarity error measurement is suitable for the maintenance of repeaters in manholes and on poles.

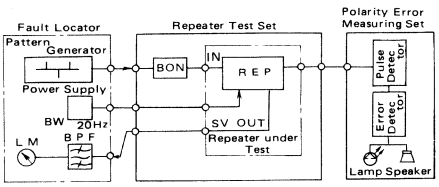


GENERAL INFORMATION

C Quality Evaluation at the Repeater

C-1 Margin Test

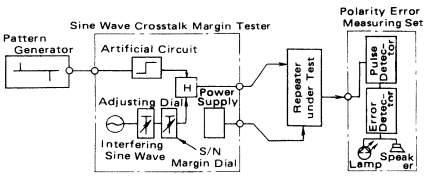
A repeater under test is inserted in the repeater test set and the low frequency component level and polarity error are measured in order to evaluate the quality at the repeater.



- The pulse density is varied by the pattern generator of the fault locator and the low frequency component level of the supervised output (SV OUT) and polarity errors are measured in order to evaluate the performance of the repeater.
- BON is an artificial circuit which is equivalent in attenuation to the line length of one repeater span.

C-2 Sine Wave Crosstalk Margin Measurement

A repeater under test is connected to the sine wave crosstalk margin tester. A particular pattern is applied to the repeater and its output is checked for polarity errors by means of a polarity error measuring set.

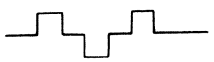


- The pattern signal and the interfering sine wave (800 kHz) are synthesized and adjusted to an equal level by the equalizing preamplifier.
- The S/N margin dial is turned, while observing the polarity error measuring set after artificial circuit loss setting and initial level setting, the insertion error disappears or does not occur any longer. The S/N margin dial reading taken at this point indicates the S/N margin (sine wave crosstalk margin).

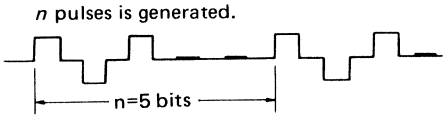
D Fault Location

For locating a repeater at fault, a signal containing a low frequency component in the bipolar pulse row is transmitted from the supervising terminal equipment in order to increase mutual code interference on purpose, and the faulty repeater is located according to the decrease in the low frequency component level. This so-called trio pulse method is in wide use in repeater fault location.

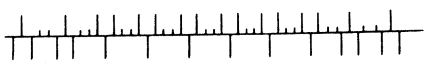
(1) The term trio pulse refers to a row of basic pulses consisting of one pair of double-current pulses and one single-current pulse, as shown below.



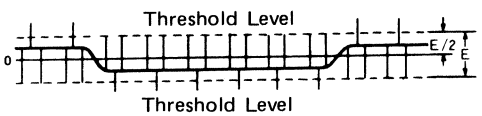
(2) The pattern which repeats itself at every *n* pulses is generated.

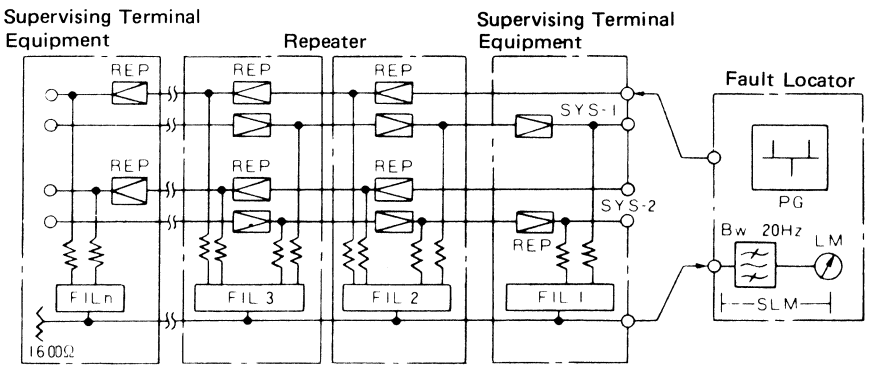


(3) Some parts of *n*-bit signals are switched to reverse polarity by a low frequency.



(4) When each pulse is averaged, the DC rms level varies with numbers of positive and negative pulses as shown below with the thick line, providing a low frequency component.





D-1 Fault Location

The fault locator sends a trio pulse to the repeaters through the transmission line. Each repeater has a filter with different pass band frequency, and the low frequency component is returned to the fault locator through the filter. Any repeater at fault can be located as the decrease of the low frequency component level returned to the fault locator.

D-2 Repeater Margin Test

The repeater margin test is made the same as the fault location by adding a low frequency component and changing two pulse density. The measured value is referred to the table. The margin is specified from the pulse density and low frequency component relative level shown in the table. In this case, the allowable deviation of low frequency component relative level and the measured value is within ±1 dB.

Margin	Pulse Density (bits)	Low Frequency Component Relative Level (dB)
0	11	0
1	10	0.8
2	9	1.11
3	8	2.8
4	7	3.9
5	6	5.3
6	5	6.9
7	4	8.8

PCM LINE TEST SET

TYPE AP-9600

The AP-9600 PCM Line Test Set is used for PCM transmission line maintenance measurements and repeater pre-installation tests.
The AP-9600 accommodates a transmitter section and a receiver section in one cabinet. It also contains a BON (building-out network) for repeater pre-installation tests.
The major measurement items are as follows:

1. Span line performance tests:
   a. Fault locating
   b. Density margin
   c. Code violation
2. Repeater pre-installation tests:
   a. Density margin
   b. Code violation

Note: As an upper version model of the AP-9600, the AP-9605 is offered. The AP-9605 has the following capabilities in addition to the performance characteristics of the AP-9600.

1. DC fault location (±50V supply voltage)
2. Voltage/current measurement (250V/99.9mA)

SPECIFICATIONS

Supervisory signal:	
Waveform:	Pulse trio, ±, + and −.
Pulse trio density:	1/11 to 1/4.
Supervising frequency:	24 frequencies.
Signal output:	
Repetition frequency:	2048 kHz ± 100 ppm.
Pattern:	Pseudo random pattern (32767 bits) and all marks.
Format:	AMI, HDB3.
Error injection:	Inject an error every one second.
Level:	3 V_0-p/120 Ω (CCITT pulse mask). 2.37 V_0-p/75Ω (CCITT pulse mask).
Supervisory signal input:	
Level range:	−95 to +5 dBm.
Impedance:	1600 Ω, balanced.
Passband width:	20 Hz or less.
PCM signal input:	
Input level range:	2.4 to 3.6 V_0-p/120 Ω, high (>2 kΩ). 1.0 to 2.6 V_0-p/75 Ω, high (>2 kΩ).
Current source for repeater:	48 ± 2 mA.
Building-out network:	40 dB attenuated BON at 1024 kHz (see Table). 30 dB attenuated BON at 1024 kHz (see Table).
Code violation measurement:	
Gate time:	10^7, 10^8, 10^9, 10^{10} bits and ∞.
Indication:	4 digits, LED display.

Power requirements:	230V AC, 50/60Hz; approx. 60VA.
Dimensions:	Approx. 200(H) x 425(W) x 350(D) mm.
Weight:	Approx. 14.5 kg.
Accessories supplied:	Five cables, three fuses.

Frequency (kHz)	Loss (dB)		Tolerance (dB)
	30dB	40dB	
20	4.5	6.0	±1.5
40	5.4	7.2	±1.5
60	6.3	8.4	±1.5
80	7.3	9.7	±1.5
100	8.1	10.8	±1.5
150	9.9	13.2	±1.5
200	11.6	15.5	±1.5
300	14.6	19.5	±1.5
400	17.3	23.0	±1.5
500	19.7	26.2	±1.5
600	21.9	29.2	±1.5
800	25.8	34.4	±1.5
1024	30.0	40.0	±0.4
1500	37.6	50.1	±2
2000	44.6	59.4	±2

Characteristics of the Building-out Network

PCM-24 MEASURING TEST SET
TYPE AP-9100

- *Best suited for maintenance and test of terminal equipment and repeated line in PCM-24 system*
- *Combines various testing capabilities into one instrument*

This instrument is exclusively designed for maintenance of the terminal equipment and repeated line of the PCM-24 system, and it can execute various tests listed below. If your application requires rack mount type, Ando offers the AP-9100-A which is designed to be mounted on a terminal equipment frame.

TEST FUNCTIONS

Terminal office tests

(1) Net loss level characteristics measurement
(2) Quantizing noise level measurement
(3) Noise level measurement during absence of call
(4) Psophometic noise level measurement

Repeated line tests

(1) Repeater fault locating
(2) Interference margin tests

The AP-9100 combines all these testing capabilities into one instrument.

FEATURES

- Location of troubles in max. 24 repeaters is possible.
- Measurements of major noise levels, such as quantizing noise level, noise level during absence of call, and psophometric noise level, are possible in PCM communications.
- This instrument is also available as a pulse pattern generator for polarity error measurement.
- This instrument is also available as a flat level measuring instrument in voice frequency bands.
- The measuring indicator lamps provided for respective functions facilitate the operation.

TYPE AP-9100, PCM-24 MEASURING TEST SET

SPECIFICATIONS

1. Transmitting Section

1-1 900Hz output

Frequency:	900Hz ±0.2%.
Output level:	−5, −8, −38, −48dBm (push-button selection).
Output impedance:	600Ω balanced.
Harmonic distortion:	50dB or more (with reference to −5dBm output).

1-2 Pulse output

Clock frequency:	1.544MHz ±500Hz.
Pattern:	Fault locating signal (pulse-trio): polarity, ±, +, −; density, 1/6, 1/8, 1/11. Pseudo-random signal: Cycle, 2047 bits
Waveform:	Non-linear equalized bipolar square wave (half-width, 0.324 ±0.033μs; terminated into 110Ω).
Output voltage:	$3V_{o\text{-}p}$ (terminated into 110Ω).

2. Receiving Section

2-1 Flat level measurement

Frequency range:	300 to 3400Hz.
Measurement range:	Residual loss • idle channel noise: −60 to +10dBm Quantizing noise: −80 to −10dBm
Step accuracy:	Within 0.3dB.
Frequency response:	±0.3dB (with reference to 900Hz, 0dBm).
Input impedance:	600Ω balanced; return loss 26dB or more.
Level calibration:	±0.2dB (with reference to 900Hz, 0dBm).

2-2 Fault location

Frequency range:	1005 to 3016Hz (24 frequencies).
Level measurement range:	−95 to −35 dBm.
Input impedance:	1600Ω balanced; return loss, 15dB or more.

2-3 Built-in filters (for noise measurements)

For psophometic noise measurement:	Telephone, CCITT P.53.
Quantizing noise measurement:	900Hz band-elimination filter.

3. General

Power requirements:	100V AC ±10%, 50/60Hz; approx. 30VA.
Dimensions:	Approx. 200(H) x 410(W) x 220(D) mm.
Weight:	Approx. 15kg.
Accessories supplied:	Two measurement cables, 3 m long each (terminated on both ends with M-1PS connectors). One power cable, 5 m long.

TYPE AP-9100-A (rack mount type)

PCM LINE TEST SET
TYPE AP-9603

The AP-9603 PCM Line Test Set is used for PCM transmission line maintenance measurements and repeater pre-installation tests.
The AP-9603 accommodates a transmitter section and a receiver section in one cabinet. It also contains a BON (building-out network) for repeater pre-installation tests.
The major measurement items are as follows:

1. Span line performance tests:
   a. Fault locating
   b. Density margin
   c. Code violation
2. Repeater pre-installation tests:
   a. Density margin
   b. Code violation

SPECIFICATIONS

Supervisory signal:
- Waveform: Pulse trio, ±, + and −.
- Pulse trio density: 1/11 to 1/4.
- Supervising frequency: 24 frequencies.

Signal output:
- Repetition frequency: 1544 kHz ±30 ppm, 3152 kHz±30 ppm
- Pattern: Pseudo random pattern (32767 bits) and all marks.
- Format: AMI
- Error injection: Inject five errors in 10^7 bits
- Level: $3V_{0\text{-}p}/100\Omega$ or 105Ω

Supervisory signal input:
- Level range: −95 to +5 dBm.
- Impedance: 1600Ω, balanced.
- Passband width: 20 Hz or less.

PCM signal input:
- Input level range: 2.4 to 3.6 $V_{0\text{-}p}/100\Omega$ or 105Ω, high (>2 kΩ).

Current source of repeater: 48, 60, 100 mA.

Building-out network: 10, 32 and 42 dB attenuated BON at 772 kHz (see Table).

Code violation measurement:
- Gate time: 10^7, 10^8, 10^9, 10^{10} bits and ∞.
- Indication: 4 digits, LED display.

Power requirements: 100V, 110V/115V/120V, 220V, 230V/240V AC, 50/60 Hz; approx. 55 VA

Dimensions: Approx. 200(H) x 425(W) x 350(D) mm.

Weight: Approx. 16.5 kg.

Accessories: Three cables

Frequency (kHz)	Loss (dB)			Tolerance (dB)
	10dB	32dB	42dB	
10	1.0	3.2	4.1	±1.5
50	2.3	7.2	9.5	±1.0
100	3.2	10.4	13.6	±1.0
200	4.7	15.1	19.8	±1.0
300	5.9	18.8	24.7	±1.0
400	6.9	22.0	28.9	±1.0
600	8.7	27.7	36.4	±1.0
772	10.0	32.0	42.0	±0.4
1000	11.6	37.2	48.8	±1.0
1576	15.2	48.7	64.0	±1.0
2000	17.6	56.3	73.9	±2.0
3000	22.7	72.5	–	±2.0

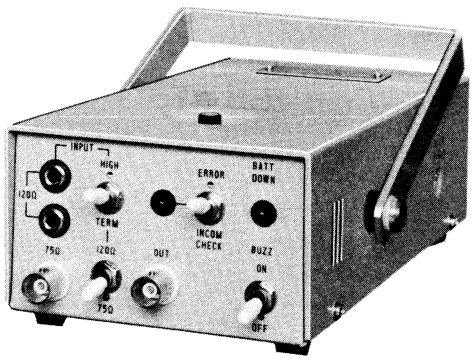
Characteristics of the Building-out Network

BIPOLAR ERROR DETECTORS

TYPE AP-7601 (1.544/3.152 MHz), TYPE EBT-5E (2.048 MHz)

The bipolar error detectors Types AP-7601 and EBT-5E are used to detect the bipolar errors contained in the bipolar pulse train when the pulse is transmitted through PCM system repeated line. The lamp lights and the buzzer gives a sound when such erros are detected.
The instruments also find their applications in the performance test of a repeater itself. Their compact and lightweight construction permits easy testing in a manhole or on the pole.

TYPE AP-7601



TYPE EBT-5E

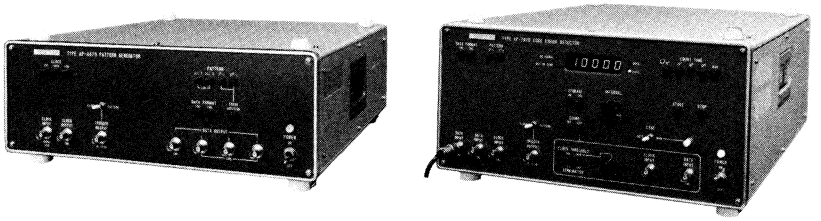
SPECIFICATIONS

Type		AP-7601	EBT-5E
Repetition frequency		1.5 to 3.2 MHz	2.048 MHz
Input pulse	Code	AMI	HDB3
	Level	2.4 to 3.6 $V_{0\text{-}p}$ (105 Ω)	2.4 to 3.6 $V_{0\text{-}p}$ (120 Ω) 1.9 to 2.8 $V_{0\text{-}p}$ (75 Ω)
Input impedance	Terminated	105 Ω, balanced	75 Ω, 120 Ω, balanced
	Parallel	2 kΩ or more	2 kΩ or more
Error indication		Lamp (LED), buzzer	
Input check		LED lights to indicate that input signal is present.	
Battery voltage check		LED lights to indicate that voltage decreases.	
Error output		An output of 1 $V_{0\text{-}p}$ is generated when error occurs.	
Power requrements		Built-in battery (SUM3 x 6) or AC adapter (option)	
Dimensions		Approx. 60(H) x 100(W) x 200(D) mm	
Weight		Approx. 950 g	

PCM-140M CODE ERROR MEASURING SETS

TYPE AP-4870 PATTERN GENERATOR
TYPE AP-7870 CODE ERROR DETECTOR

The PCM-140M Code Error Measuring Set is composed of Type AP-4870 Pattern Generator and Type AP-7870 Code Error Detector, and is used for tests of the high speed digital transmission system up to 150 Mbits.



TYPE AP-4870 TYPE AP-7870

FEATURES

- Delay pattern output
- Quasi-error insertion
- External clock operation from 1 to 150 Mbits
- Synchronous output for waveform observation
- Far-end and near-end measurements
- Pulse counts capability

SPECIFICATIONS

Type AP-4870 Pattern Generator

Clock:
- Internal clock: 139.264 MHz ±15 ppm.
- External clock: 1 to 150 MHz (0 dBm/75Ω).

Pattern:
- Pseudo random: 2^6-1 bits and 2^{15}-1 bits.
- Fixed: All "1" and all "0" at 139.264 MHz and CMI output.
- Error injection: Inject one error in 10^4 bits for pseudo random pattern.

Output:
- Clock: 75Ω CML
- Data: (1) One output compatible with CCITT recommendation G751 (75Ω CMI). (2) Three NRZ data outputs by external clock (75Ω CML).

Delayed pattern output: In case of (2), three bits delay and six bits delay outputs are provided.

Synchronous pattern output: 75Ω 0/-0.5V (trigger for waveform observation).

Power requirements: 100V AC 50/60 Hz, approx. 64VA.

Dimensions: Approx. 150(H) x 425(W) x 450(D) mm.

Weight: Approx. 9 kg.

Type AP-7870 Code Error Detector

Measuring input pulse:
- Repetition frequency: (1) 139.264 MHz ±15 ppm (CMI). (2) NRZ data of 1 to 150 MHz (CML).

In case of (2) need the clock input.

Code error measurement:
- Measuring pattern: Pseudo random pattern (2^6-1, 2^{15}-1).
- Measuring time: 10^4, 10^6, 10^8, 10^{10} bits and manual.
- Pattern synchronization: Auto/manual (resynchronize when occurring the code error of 10^{-2} or more under the auto count).
- Indication of measured result: Storage/non-storage, 5-digit decimal.
- Release time of measurement: The time from end to start of measurement is variable approximately from 0.5 to 2 sec.
- Alarm indication: Input off, synchronization loss, overflow.

Pulse count:
- Measuring time: Same as code error measurement.
- Indication of measured result: Same as code error measurement.
- Release time of measurement: Same as code error measurement.

Synchronous pattern output: 75Ω, 0/-0.5V (trigger for waveform observation).

Power requirements: 100V AC 50/60 Hz, approx. 100VA.

Dimensions & weight: Approx. 200(H) x 425(W) x 450(D) mm, approx. 12 kg.

PCM CHANNEL TEST SET
TYPE AP-9601

The AP-9601 PCM Channel Test Set is used for PCM multiplex terminal equipment maintenance measurements (CCITT recommendation G712).
The AP-9601 accommodates a transmitter section and a receiving section in one cabinet.
The major measurement items are as follows:

a. Variation of gain with input level
b. Attenuation/frequency distortion
c. Quantizing distortion
d. Idle channel noise
e. Interchannel crosstalk

SPECIFICATIONS

Transmitter section:
- Sine wave frequency: 300, 820, 3000, 3400 Hz.
- Accuracy: ±0.5%.
- Harmonic distortion: More than 30 dB at +10 dBm output. More than 50 dB at 820 Hz.
- Send level: -60 to +10 dBm0 in 1 dB steps.
- Send relative level: -16.5 to +2 dBr in 0.5 dB steps.
- Output impedance: 600, 900 Ω switchable, balanced.

Receiver section:
- Input impedance: 600, 900 Ω switchable, balanced.
- Frequency range: 300 to 3400 Hz.
- Input level range:
  - Variation of gain with input level (with a sine wave signal): -60 to +10 dBm0.
  - Attenuation/frequency distortion: -60 to +10 dBm0.
  - Quantizing distortion: -60 to +10 dBm0.
  - Idle channel noise: -70 to -10 dBm0 (down to -80 dBm0 including meter range).
  - Interchannel crosstalk: -70 to -10 dBm0 (down to -80 dBm0 including meter range).
- Receiver relative level: -15.5 to +7 dBr in 0.5 dB steps.
- Receive level: -60 to +10 dBm0.
- Weighting network: This weighting network is used when quantizing distortion and idle channel noise are measured. The characteristics of the weighting network is shown in Table.

Power requirements: 100V AC, 50/60 Hz; approx. 12.5V A.

Dimensions: Approx. 150(H) x 425(W) x 350(D) mm.

Weight: Approx. 9.5 kg.

Accessories supplied: Three cables, three fuses.

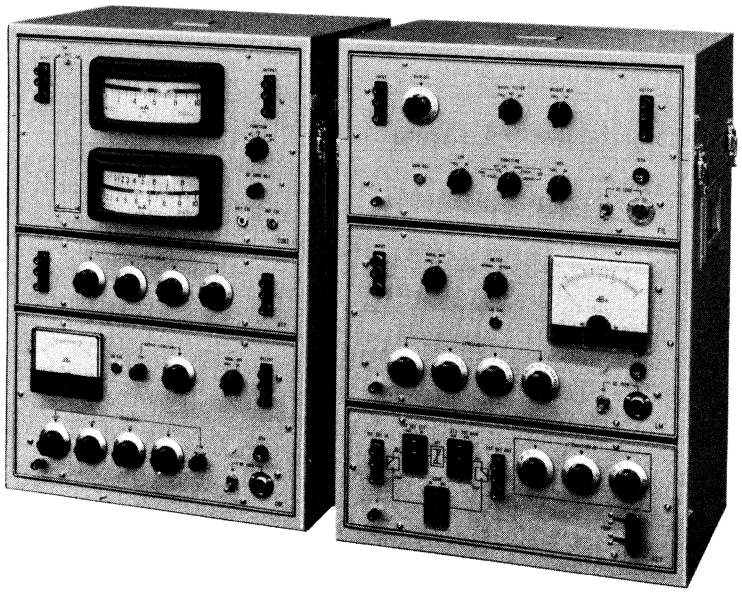
Frequency (Hz)	Weight value (dB)	Tolerance (dB)
300	-10.0	±1
400	- 6.3	±1
500	- 3.6	±1
600	- 2.0	±1
800	0	0
1000	+ 1.0	±1
1200	0	±1
1500	- 1.3	±1
2000	- 3.0	±1
2500	- 4.2	±1
3000	- 5.6	±1
3500	- 8.5	±2

Telephone Circuit Psophometer Weighting Coefficient

TRANSMISSION MEASURING SETS

TYPES AP-9701/PMS-11

The AP-9701 and PMS-11 PCM transmission measuring instruments are capable of making various transmission characteristics measurements, such as quantizing noise in short-distance PCM transmission paths, idle channel noise, harmonic distortion, residual loss level characteristics, residual loss frequency response, overload characteristics, crosstalk, etc.
The measuring frequency (except residual loss level characteristics measurement) is 810Hz for the AP-9701 and 800Hz the PMS-11.



TYPE PMS-11

SPECIFICATIONS

Oscillator Section:

Frequency range:	50 to 8000 Hz variable in 1 Hz steps.
Output impedance:	600 Ω balanced.
Output level:	0 to +15 dBm (adjustable in 1 dB steps with fine control)
2nd and 3rd harmonic distortion attenuation:	30 dB or more
Dimensions	Approx. 220 (H) x 400(W) x 280 (D) mm

Level Calibrator Section:

Frequency range:	DC to 8 kHz.
Impedance:	600 Ω balanced.
Input level:	Approx. +14 dBm.
Sending level:	+5 dBm (accuracy: within ±0.1 dB).
Power requirements:	4.5V (batteries)
Dimensions:	Approx. 250 (H) x 400 (W) x 280 (D) mm.

Attenuator Section 1:

Frequency range:	DC to 8 kHz.
Attenuation range:	0 to 91 dB in 0.1 dB steps.
Input/output impedance:	600 Ω balanced.
Dimensions:	Approx. 100 (H) x 400 (W) x 280 (D) mm.

Attenuator Section 2:

Frequency range:	DC to 8 kHz.
Attenuation range:	0 to 71 dB in 0.1 dB steps.
Input/output impedance:	600 Ω balanced.
Dimensions:	Approx. 150 (H) x 400 (W) x 280 (D) mm.

Filter Section:

Gain:	-10 to +20 dB in 5 dB steps.
Input/output impedance:	600 Ω balanced.

Types of filters:

AP-9701	PMS-11
810Hz BPF, 810Hz BEF, Weighting network, 1620Hz BPF, 2430Hz BPF, 8000Hz BPF, 3400Hz LPF, 300Hz HPF	900Hz BPF, 900Hz BEF, Weighting network, 1800Hz BPF, 2700Hz BPF, 8000Hz BPF, 3400Hz LPF, 300Hz HPF

Dimensions:	Approx. 200 (H) x 400 (W) x 280 (D) mm.

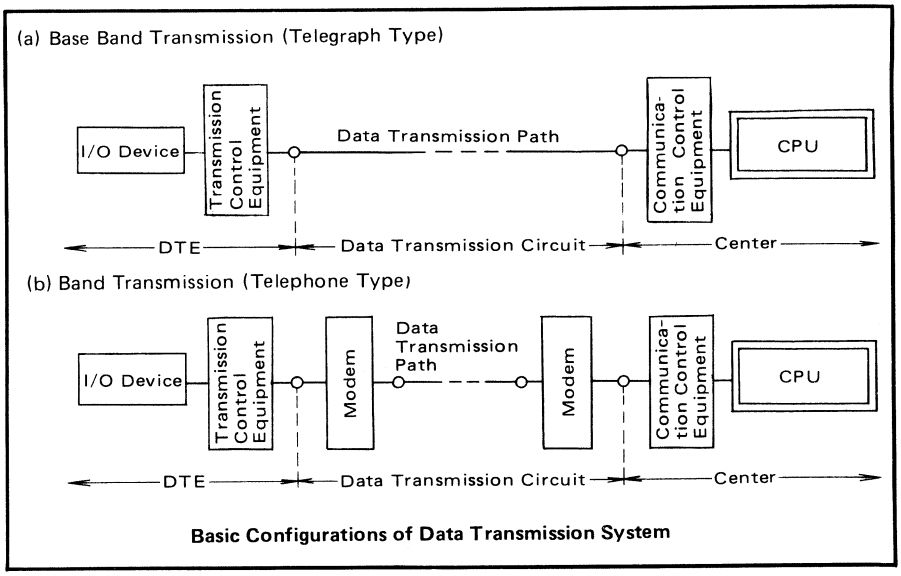
Level Meter Section:

Frequency range:	50 to 8000 Hz.
Measurement range:	-60 to +15 dBm (-70 to +15 dBm including meter range).
Input impedance:	600 Ω balanced.
Meter scale:	-10 to 0 dBm (minimum scale 0.01 dB).
Dimensions:	Approx. 200 (H) x 400 (W) x 280 (D) mm.

11 DATA TRANSMISSION MEASURING SETS

GENERAL INFORMATION

The data transmission system is basically divisible into two types, as shown right. The system (a) above includes systems which use direct current transmission over the entire path from the DTE to the CPU and those which use analog signal transmission in part of the transmission path. Systems of type (b), on the other hand, adopt analog signal transmission through the use of a modem at each terminal. Data transmission measuring sets are designed for evaluating the quality of data transmission or testing the performance of modems and terminal equipment or perform both of these functions.



Basic Configurations of Data Transmission System

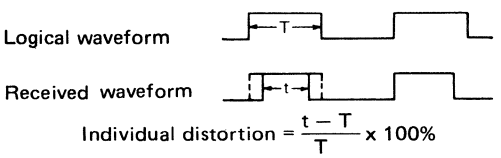
A Evaluation of the Quality of Data Transmission

The factors affecting the deterioration data transmission quality are level and frequency variations, attenuation distortion, phase distortion, noise, and hits. In the evaluation of the quality of analog signal transmission, oscillators, level meters, phase (group delay) measuring sets and other various transmission measuring sets are employed.
From the standpoint of direct current binary code, on the other hand, those deterioration factors cause the direct current binary code to give rise to code distortion. This eventually leads to data errors. Accordingly, DC binary code generators, code distortion measuring sets and error rate measuring sets are used as instruments in the evaluation of the quality of data transmission. Special instruments, such as impact noise counter and hits are also used in transmission measurement.

A-1 Code Distortion Measurement

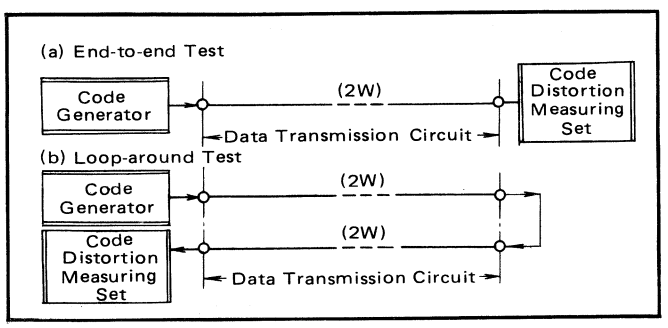
(1) Individual Distortion

- The term individual distortion refers to the distortion of the code itself; should a given significant instant (point of transition of direct currents "1" and "0") deviate from the ideal instant, the ratio of such deviation to the unit interval is referred to as individual distortion.

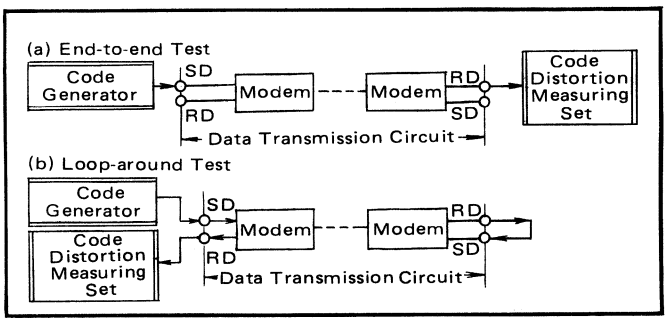


$$\text{Individual distortion} = \frac{t - T}{T} \times 100\%$$

- The distortion between two neighboring significant instants is measured. Clock pulses are generated, using the rise (or fall) significant instant of the received code as the reference to obtain a time scale (reference time axis) which assigns the value 100% to one bit length. If the rise (or fall) significant instant of the received code is prolonged to an interval longer than 0% on the time scale, it is referred to as "+" distortion, and if the rise (or fall) significant instant of the received code is compressed to an interval shorter than 0% on the time scale, it is referred to as "−" distortion. The distortion of the received code is measured over the range of −50 to +50%.



(I) Base Band Transmission Measurement Configuration

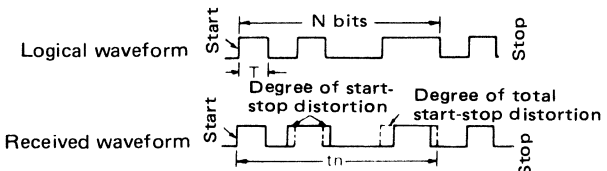


(II) Band Transmission Measurement Configuration

GENERAL INFORMATION

(2) Total Start-stop Distortion

- The term start-stop distortion refers to the logical difference between the significant instant of each bit and that of the start element immediately before it, and the largest of all start-stop distortions is referred to as the degree of total (maximum) start-stop distortion. The degree of total start-stop distortion is obtained by measuring maximum values irregular distortion including regular distortion.

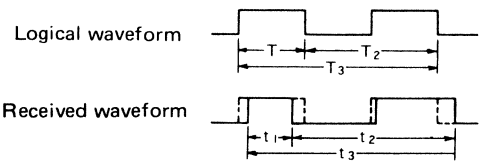


$$\text{Degree of start-stop distortion} = \frac{tn - T \cdot N}{T} \times 100\%$$

- Clock pulses are generated, using the rise significant instant of the start bit of the received code of start-stop system comprising one character as the reference to obtain a time scale which assigns the value 100% to one bit length. If each significant interval immediately before the stop bit is prolonged to an interval longer than 0% on the time scale, it is referred to as "+" distortion, and if each significant interval immediately before the stop bit is compressed to an interval shorter than 0% on the time scale, it is referred to as "−" distortion. The distortion of the received code is measured for each significant interval over the range of −50 to +50%.

(3) Isochronous Distortion

- The term isochronous distortion refers to the ratio of the maximum difference between given logic and actual significant intervals to the unit time. Isochronous distortion has nothing to do with the plus-or-minus sign of the code, and two significant instants where isochronous distortion occurs need not be continuous.



$$\delta_1 = \left|\frac{T - t_1}{T}\right| \times 100\%$$

$$\delta_2 = \left|\frac{T_2 - t_2}{T}\right| \times 100\% \qquad \delta_3 < \delta_1 < \delta_2 \ldots\ldots < \delta\max$$

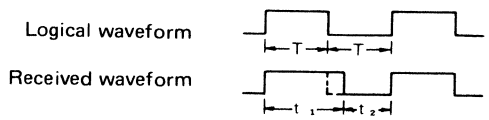
$$\delta_3 = \left|\frac{T_3 - t_3}{T}\right| \times 100\%$$

$\delta\max$ = degree of isochronous distortion

- To measure distortion between two given significant intervals, it is necessary to monitor the received code for its phase difference from the time scale at all times and compensate it for a phase difference if any. In this state the maximum values of plus and minus distortion are obtained, and the sum of absolute values of such distortion is the degree of isochronous distortion. Accordingly, isochronous distortion has nothing to do with the plus-or-minus sign of the code so that it is measured over the range of 0 to 100%.

(4) Bias Distortion

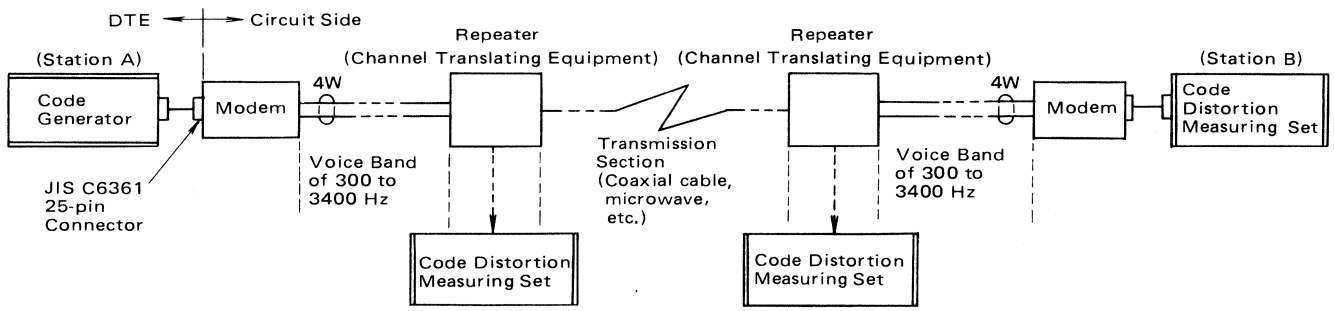
- The term bias distortion refers to a mean value of the ratio of the time length difference between space and mark codes to the logic time interval.



$$\text{Bias distortion} = \frac{t_1 - t_2}{t_1 + t_2} \times 100\%$$

$$= \frac{t_1 - t_2}{2T} \times 100\%$$

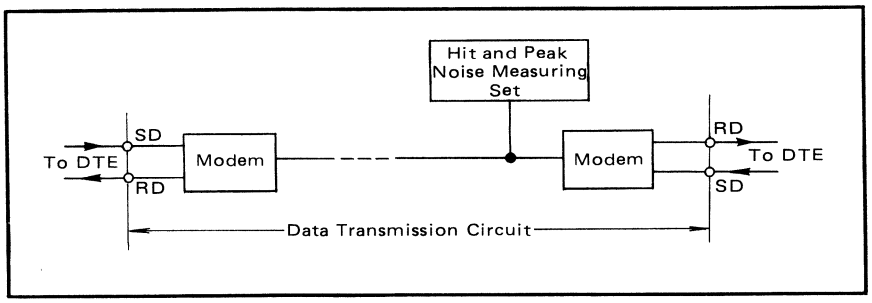
- The direction of current flow is changed by mark and space codes in a zero center indicating meter and the distortion ratio of mark to space code is indicated on the meter scale. If codes other than [1:1] are used, the mark-to-space code ratio of current flowing to the meter is changed so as to achieve a state equivalent to the [1:1] code.



The configuration shown above is an example for end-to-end code distortion measurement (transmission from station A to station B).
This configuration permits measurement of all characteristics of the transmission circuit (Modem — Voice Band Section — Channel Translating Equipment — Transmission Section).

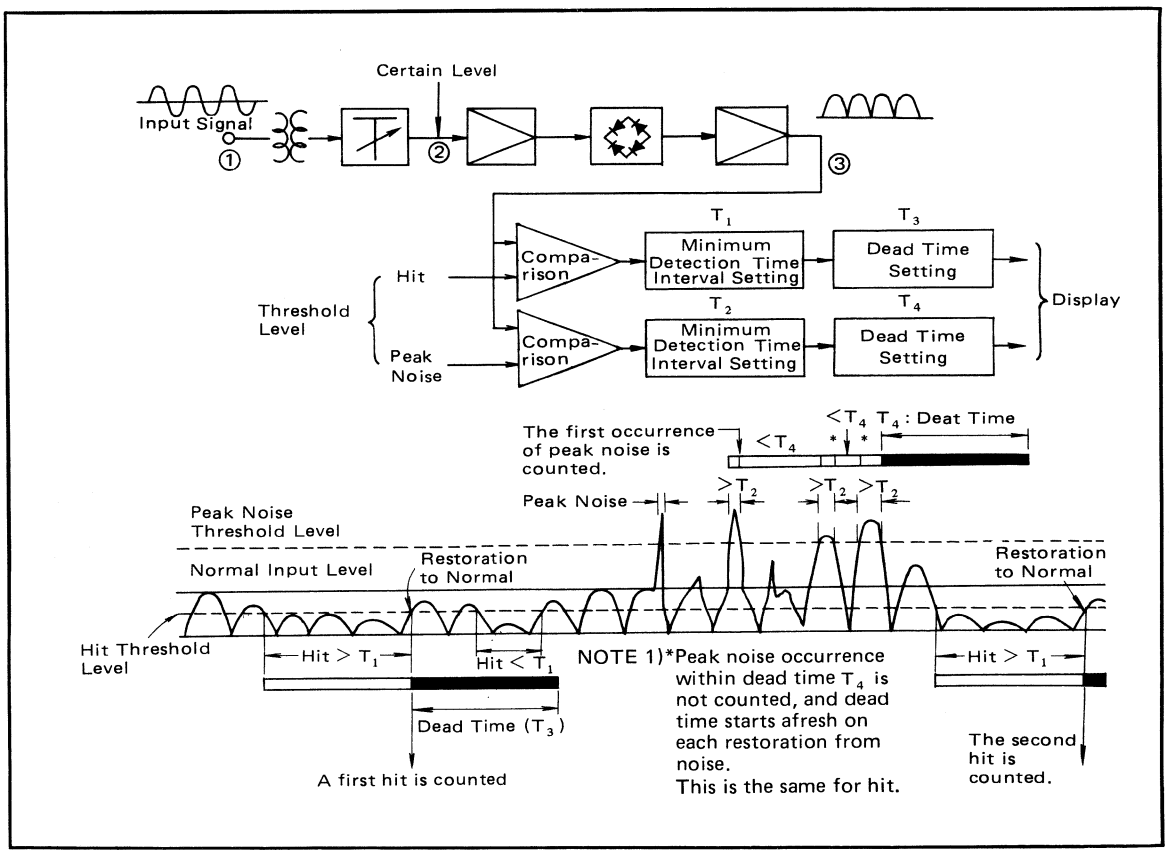
Code Distortion Measurement Configuration

A-2 Hit and Peak Noise Measurement



- Peak noise and hits which may occur in the data transmission path at work are measured in this configuration of data transmission measuring sets. Should a hit occur in the transmission path at work, it causes part of data being transmitted to be lost. The greater part of code errors are due to hits. The measurement of hits therefore provides a very effective means to find the cause of distortion and code errors.

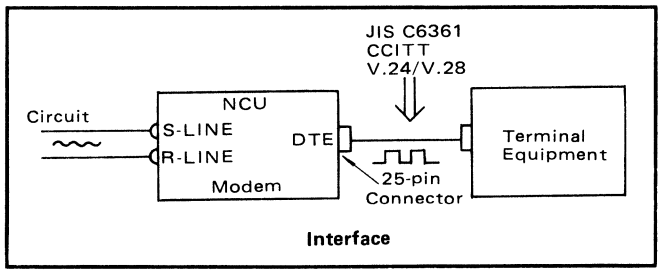
- The hit and peak noise measuring set has the following circuitry. The input signals are full-wave rectified so that measurements can be made irrespective of the polarity of the input signal. As shown below, when the peak value of normal input signals continue below a certain threshold level for time T_1 or longer, it is counted as one hit. When peak noise continues above a certain threshold level for time T_2 or longer, it is counted as one occurrence of peak noise.



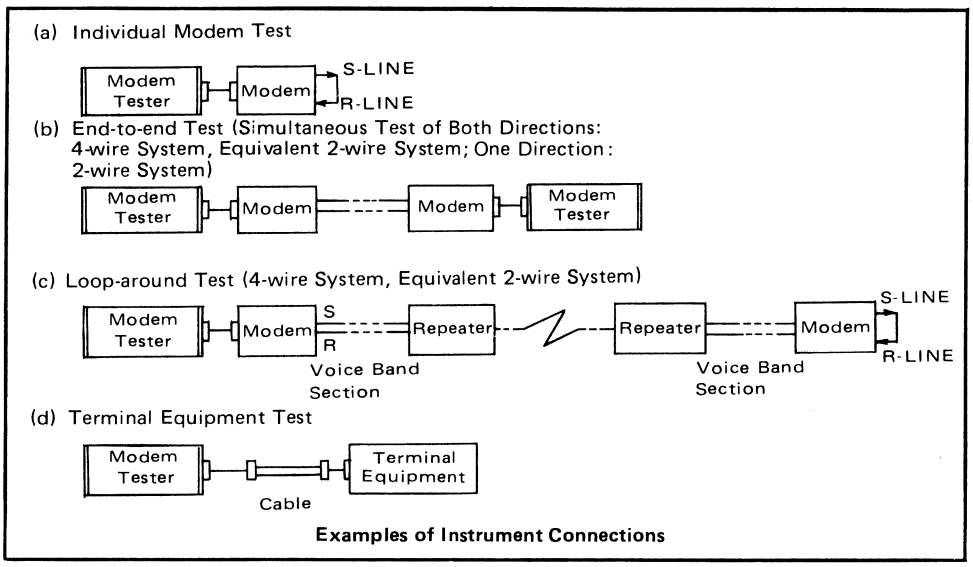
GENERAL INFORMATION

B Modem Tester

The modem tester is used in testing the modem and data transmission circuit. It provides very effective means to locate the faults and adjust the modem. Modems generally have such interface as shown right. The modem tester checks each modem interface for compliance with the electrical standard and makes the measurements of code distortion, error bits, etc., directly in individua modems or through circuits.



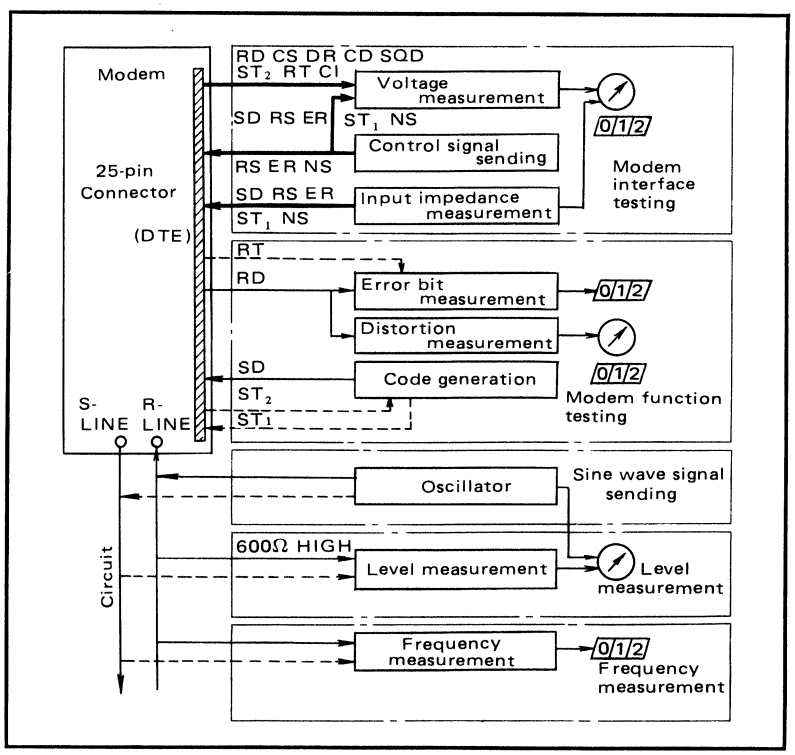
Interface



Examples of Instrument Connections

Test Functions

Ando offers a variety of modem testers which perform various combinations of the following functions.



CODE GENERATOR
TYPE PW-105B

The PW-105B Code Generator is designed for use in the measurement and adjustment of telegraph and data transmission circuits, carrier telegraph equipment and terminal equipment as a test code (reference code) source. The code generator is used in conjunction with a code distortion measuring set or an error rate measuring set.

FEATURES

- Capable of setting distortion to a code.
- Capable of generating the SQ9 code (CCITT R.51)
- Finds use in both the single-current and double-current circuits.

SPECIFICATIONS

Data signalling rates:	50, 75, 100, 150, 200 bit/s
Synchronous mode:	Start-stop system (5-unit code)
Test codes:	1:1, 2:2, 1:6, 6:1, SQ9, +, -
Code distortion:	±0.5%
Output voltage and current:	10 to 40 mA into 0.5 to 3 kΩ load; both single-current and double-current circuits can be switched 120Vp-p max. output
Distortion setting:	Amount of distortion: ±(0 to 50)% in 1% increments Distortion is set at the transition point of a start bit Setting accuracy: ±0.5%
Power requirements:	100V AC, 50/60 Hz; approx. 50 VA
Dimensions:	Approx. 200(H) x 280(W) x 400(D) mm
Weight:	Approx. 10 kg

START-STOP DISTORTION MEASURING SET
TYPE TGK-13F

The TGK-13F Start-stop Code Distortion Measuring Set is designed for use in the measurement or observation of the distortion of codes transmitted from a code generator or terminal equipment through a data transmission circuit.
It is not only of value in the evaluation of the quality of the data transmission circuit but is effective in the test and adjustment of terminal equipment.

FEATURES

- Can find use in both balanced and unbalanced circuits.
- Can indicate the X-pattern of the rise and fall of codes on a CRT display.

SPECIFICATIONS

Data signalling rates:	50, 75, 100, 150, 200 bit/s External, 50 to 200 bit/s
Measurement range:	Total distortion: 0 to ±47% Element distortion: 0 to ±47%
Measurement accuracy:	±0.5%
Indication:	CRT display
Input voltage and current:	Balanced circuit: ±(10±3) mA ±(20±3) mA Unbalanced circuit: Double current: ±6 to ±50V ∓6 to ∓50V Single current: +6 to +100V -6 to -50V
Code unit:	5-, 6-, and 8-unit
Unbalanced circuit slice voltage:	5, 10, 20, 30 V
Power requirements:	100V AC, 50/60 Hz; approx. 50VA
Dimensions:	Approx. 300(H) x 250(W) x 435(D) mm (with front panel cover)
Weight:	Approx. 14 kg

IMPULSIVE NOISE/LEVEL HIT MEASURING SET

TYPE ASA-23

The ASA-23 Impulsive Noise/Level Hit Measuring Set is designed for use in the measurement of the number of level hit and impulsive noise occurring in data transmission lines, and give the digital indication of the number of the hit or peak noise that drops below or exceeds the preset specified level.

The impulsive noise can be measured in accordance with V.55 of CCITT recommendations.

SPECIFICATIONS

Frequency range:	0.3 to 3.4 kHz
Input impedance:	600Ω and HIGH
Input level:	-50 to 0 dBm in 1 dB steps
Detection level and time length:	1. Hit: -50 to 0 dBm in 1 dB steps 0.9 to 1.1 ms and 0.4 to 0.6 ms 2. Impulsive noise: -50 to 0 dBm in 1 dB steps 30 to 50μs
Indication and external output:	Indication: 4-digit decimal display with an overflow lamp. External output (3.5 kΩ load): Normal, +(8±1)V; during detection, -(8±1)V.
Timer:	5, 10, 15, 30 min. and manual.
Power requirements:	100V AC, 50/60 Hz
Dimensions:	Approx. 150(H) x 425(W) x 400(D) mm (with front panel cover)
Weight:	Approx. 13.5 kg

MODEM TESTER
TYPE TSD-502A

The TSD-502A is a 50–9600 bits/s portable modem tester with performance characteristics that make it ideally suited for testing voice band data transmission equipment.
It accommodates a digital level meter, a frequency counter, a synthesized oscillator, a digital volt-meter in an attaché case.
The AN-4102 Digital Printer is available as an option.
Measurements provided by the TSD-502A are:

a. DC voltage measurement
b. Bit error measurement
c. Block error measurement
d. Bias distortion measurement
e. Individual distortion measurement
f. Level measurement
g. Frequency measurement

FEATURES

- Portable modem tester incorporating all necessary functions
- CCITT V.24/V.28 interface
- TTL interface
- Digital display
- Printer interface

TYPE TSD-502A, MODEM TESTER

SPECIFICATIONS

Bit Error/Block Error Measurement Section

Test pattern:	511-bit pseudo-random sequence (CCITT V.52), one bit error included
Data signalling rate:	50, 100, 200, 300, 600, 1200, 2400, 3600, 4800, 9600 bits/s; 50 to 9600 bits/s (external)
Synchronization:	Synchronous, asynchronous, start-stop
Number of measurement bits:	10^3 to 10^8 in 10^1 steps and continuous
Display:	3-digit decimal display

Individual Distortion Measurement Section

Test code:	Any codes except A and Z codes
Measurement range:	0 to +50%, 0 to -50%
Display:	2-digit decimal display

Bias Distortion Measurement Section

Test codes:	1:1, 1:4, 4:1, (mark: space)
Measurement range:	0 to +50%, 0 to -50%
Display:	2-digit decimal display with polarity annunciation

Oscillator (synthesized oscillator)

Frequency range:	100 to 9999 Hz in 10 Hz steps
Frequency accuracy:	±0.05%
Output lelvel:	-40 to 0 dBm in 5 dB steps (±2.5 dB fine control provided)
Distortion:	3% or less
Output impedance:	600Ω±10%, balanced

Digital Level Meter

Input impedances:	600Ω±10%/HIGH, balanced
Level range:	-60 to +10 dBm in 0.1 dB steps
Measurement accuracy:	±1 dB
Display:	3-digit decimal display

Frequency Counter

Input (~):	600Ω±10%/HIGH, balanced; -45 to +10 dBm
Input (⊓⊔):	3 to 7 kΩ, -25 to +25V
Measurement range:	100 to 9999 Hz in 1 Hz steps
Measurement accuracy:	±1 Hz ±1 digit
Display:	4-digit decimal display

Digital Voltmeter (DC)

Measurement range:	0 to ±99.9V in 0.1V steps
Measurement accuracy:	±(1% of indicated value +0.2V)
Display:	3-digit decimal display with polarity annunciation

Interface

- CCITT V.24/V.28 interface
- TTL interface

Printer Interface

- Interface for automatic recording of bit and block errors
- For details refer to the AN-4102 digital printer

Modem Interface Monitoring Lamps

- Monitors main interface signals

Modem signals:	RC, (TC), TC, RD, TD, DSR, DCD CTS, RI, SQD
DTE signals:	RC, TC, (TC), TD, RD, DTR, RTS

Modem Interface Control Switches

- ON and OFF of the main Modem/DTE control signals

Modem control signals:	DTR, RTS, DSRS
DTE control signals:	DSR, CTS, DCD

General Specifications

Power requirements:	100V AC ±10%, 50/60 Hz.
Power consumption:	Approx. 50 VA.
Operating environment:	Temperature 5 to 35°C. Humidity 30 to 85% RH.
Dimensions:	Approx. 130(H) x 450(W) x 360 (D) mm (with front panel cover).
Weight:	Approx. 12 kg.
Accessories supplied:	One power cable, one set of connecting cables, one set of fuses.

TYPE TSD-502A, MODEM TESTER

OPTION

TYPE AN-4102 DIGITAL PRINTER

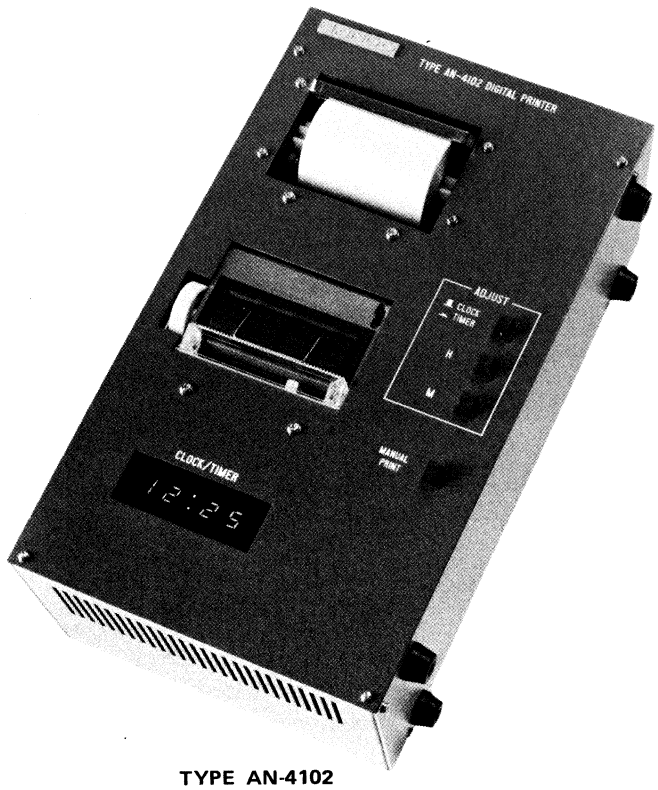
Type AN-4102 Digital Printer automatically records the bit and block errors as measured as well as time, when operated in conjunction with Type TSD-502A Modem Tester.

FUNCTION

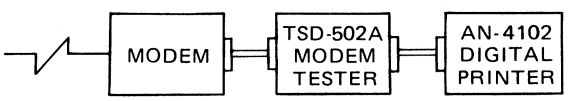
- Prints data and time at a pre-chosen time interval.
- Capable of printing a lost of synchronization, re-establishing synchronization and resuming normal measurement.
- Can print overflow.

SPECIFICATIONS

Printed character:	4 digits for indication of time, 4 digits for block errors, 6 digits for bit errors, and symbols per line.
Printing rate:	500 $^{+200}_{-140}$ ms/line.
Print interval:	1 to 99 min. (selectable in 1 minute steps)
Time indication:	00:00 to 23:59.
Manual printing:	Prints data at any desired time.
Operating environment:	Temperature, 5 to 35°C. Humidity, 30 to 85% RH.
Power requirements:	100V AC ±10%, 50/60Hz.
Power consumption:	Approx. 20 VA.
Dimensions:	Approx. 100(H) x 170(W) x 300(D) mm.
Weight:	Approx. 4 kg.
Accessories supplied:	One power cable, one connecting cable, one set of fuses, one roll of paper.



TYPE AN-4102



Example of Instrument Connections

Time	Block errors	Bit errors	Symbols	
10:10	0000	000000		(Normal print)
10:20	0001	000003		(Normal print)
10:23	0002	001000	>	(Overflow)
10:24	0001	000005	=	(Manual)
10:26	0002	000500	?	(Lost of synchro-nization)
10:36	0001	000002		(Normal print)

Examples of Printout

TELEGRAPH TEST SET
TYPE AE-1501

- *General-purpose, multi-function telegraph test set*
- *Small and compact, easy-to-carry*

The AE-1501 is a general-purpose, multi-function telegraph test set used for tests of telegraph circuits, voice frequency telegraph channels, and terminal equipment. The set incorporates a code generator, a distorton meter, a test tone oscillator, a digital level meter and a frequency counter into an easy-to-carry portable attaché case.

FUNCTIONS

- Isochronous distortion measurement
- Start-stop distortion measurement
- Bias distortion measurement
- Test code generation
- Input/output interface capabilities
- Digital level meter
- Digital frequency synthesizer
- Frequency counter

TYPE AE-1501, TELEGRAPH TEST SET

SPECIFICATIONS

■ **Telegraph circuit measurements**

Data signalling rate:	50, 75, 100, 150, 200 bauds; any rate from 50 to 200 bauds with an external clock.
Test code:	Mark, space, 1 : 1, 2 : 2, 1 : 6, 6 : 1, SQ9 (CCITT R.51), SQ9 (INV).
Stop element length:	1, 1.5, 2 bit.
Input/output current:	
Metallic return:	± (10 to 25) mA, 0.5 to 2.5 kΩ.
Earth return:	± (10 to 25) mA, 0.5 to 2.5 kΩ. + (10 to 50) mA, 0.5 to 2.5 kΩ. - (10 to 50) mA, 0.5 to 2.5 kΩ.
Isochronous distortion measurement:	
Measurement range:	0 to ±49.5%.
Measurement code:	Any code except for stop bit (1.5 bit).
Display:	3-digit decimal, digital readout.
Start-stop distortion measurement:	
Measurement range:	0 to ±49.5%.
Measurement code:	Optional 5-unit code (with start and stop bits, 1 bit or more each).
Display:	3-digit decimal, digital readout.
Bias distortion measurement:	
Measurement range:	0 to ±30%.
Measurement code:	1 : 1, 2 : 2, 1 : 6, 6 : 1.
Display:	Meter indication.
Input threshold voltage:	5, 10, 20, 30V.
Input resistance:	1 kΩ and high.

■ **Oscillator (synthesized oscillator)**

Frequency range:	0.3 to 9.99 kHz in 10 Hz steps. Frequencies are set by using digital thumb wheel switch.
Output waveform:	Sine wave.
Output level:	-40 to +10 dBm.
Output impedance:	600 Ω balanced.

■ **Digital level meter**

Frequency range:	0.3 to 10 kHz.
Measurement range:	-60 to +10 dBm.
Input impedance:	600 Ω balanced.
Display:	3-digit decimal.

■ **Frequency counter**

Frequency range:	0.3 to 10 kHz.
Input level range:	-45 to +10 dBm.
Input impedance:	600 Ω balanced.
Display:	5-digit decimal.

■ **General**

Power requirements:	100 V AC, 50/60 Hz; approx. 80 VA.
Dimensions:	Approx. 130(H) x 450(W) x 360(D) mm.
Weight:	Approx. 11 kg.
Accessories supplied:	Two fuses, four connecting cables (1 m long each), one power cable.

DATA COMMUNICATION ANALYZER
TYPE AE-5102

- *Troubleshooting Analyzer for Data Communication Network Systems*
- *Monitoring—for troubleshooting of on-line systems*
- *Simulation—as a substitute for data communication system components*

Problems occurring in the data communication systems are roughly divisible into hardware trouble (e.g., faults in the transmission path) and software trouble (e.g., protocol errors).
Hardware problems are remedied with the aid of bit error measuring sets, distortion measuring sets, level hit measuring sets, voltmeters, level meters and frequency measuring sets; one of the typical instruments for overall measurements is a modem tester. Another type of Ando instruments, the data communication analyzer is a troubleshooting instrument which has monitoring function for checking data transmission procedure and data, and for testing individual components of the data communication system.

FEATURES

- **On-line Monitoring Capability**
  As the AE-5102 monitors the protocol and data flow while the network system is operating on line, it permits easy checking of the data transmission procedure.
- **Flexible Triggering Function**
  The AE-5102 can generate triggers under various conditions, such as protocol error, parity error, block check error, specific control field in HDLC (High Level Data Link Control) or by external signals. As it permits the selection of an appropriate trigger according to the type of trouble, quick diagnosis can be made.
- **Simulation Capability**
  The AE-5102 can directly send and receive signals with individual components of the data communication system. It is ideal for checking the system performance after restoration from trouble or installation of a new data communication system. Further, this data communication analyzer provides for effective debugging of various protocols as a tool for peripheral testing and adjustment as well as for product development.
- **Sending and Receiving Capability of Any Desired Data**
  The AE-5102 is capable of sending and receiving 5- to 8-unit data in the manual or automatic mode and is also capable of automatic addition and checking of parity and block check codes (LRC, CRC).
- **Adaptability to Various Data Transmission Control Procedures**
  As the AE-5102 is adaptable to various data transmission control procedures, such as the HDLC procedure of half and full duplex communication, character-oriented synchronous method represented by the BSC and JIS C6362 and start-stop synchronous method (basic mode and transparent mode). This data communication analyzer is therefore applicable to new systems as well as existing systems.
- **No Complicated Programming**
  No special language is used for the simulation programs. Any simulation program can be easily prepared merely by entering communication messages in the memory. No special programming knowledge is required, yet simulation preparations can be made fast.
- **Sending Message Editing Capability**
- **Recording and Display of Trouble Occurrence Time**
- **Digital Magnetic Cassette Tape Recorder Provided**
- **Ease of Operation**

TYPE AE-5102, DATA COMMUNICATION ANALYZER

SPECIFICATIONS

Code system and units: Any code of 5, 6, 7 or 8 units (odd, even and no parity bits are selectable.)

Data codes: ASCII, EBCDIC, HEX, JIS (Japanese Industrial Standard)

Method of synchronization: Start-stop system (stop bits are 1, 1.5 and 2.)
Synchronous system (any synchronization code is selectable.)
HDLC (frame synchronization)

Communication method: Half duplex and full duplex

Data signalling rates: Internal clock: 50, 75, 100, 110, 134.5, 150, 200, 300. 600, 1200, 2400, 4800, 9600 bits/s
External clock: Any rate below 9600 bits/s

Interface: Conforming to the CCITT recommendations V.24/V.28 (standard)
Conforming to the CCITT recommendations X.20/V.10 (option)
Conforming to the CCITT recommendations X.21/V.11 (option)

Memory capacity: Monitoring memory: 4k characters
Simulation memory: 2k characters

Error check: Parity check: Odd, even and no bits are selectable.
Block check: LRC, CRC

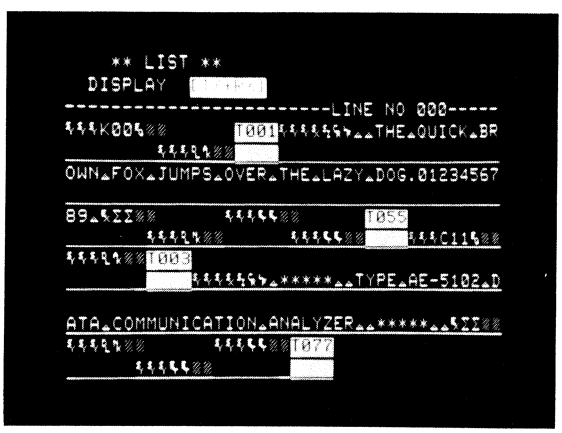
Monitoring capabilities: Trap: Monitoring results before, after or before and after the trigger event are stored in the monitor buffer memory.
Trigger conditions:
Character sequence (4 characters maximum)
Error triggers (VP, LRC, CRC)
External signal (TTL or ±8V)
Repetitive monitoring:
When the monitor buffer memory is full, its contents are transferred onto cassette magnetic tape. After completion of data transfer the monitoring operation is automatically resumed, and the cycle repeats itself.

Similation capabilities: Data transmission:
Capable of sending up to 16 message blocks (2k characters maximum) in the manual or automatic response mode.
Delay response:
Selectable over a range of 0 to 99900 ms (in 100 ms steps) after the fulfilment of sending conditions.
Sending conditions:
Receiving character sequence/ idle code detection
Data receiving:
Data received are stored with the sending data in the monitor buffer memory and indicated on the CRT display.
Display: 6 inches square CRT (40 characters x 16 lines)
Keyboard: ASCII 59 keys
Cassette tape: JIS (Japanese Industrial Standard) C6280 information dumping tape

Power requirements: 100V AC, 50/60 Hz; approx. 180 VA

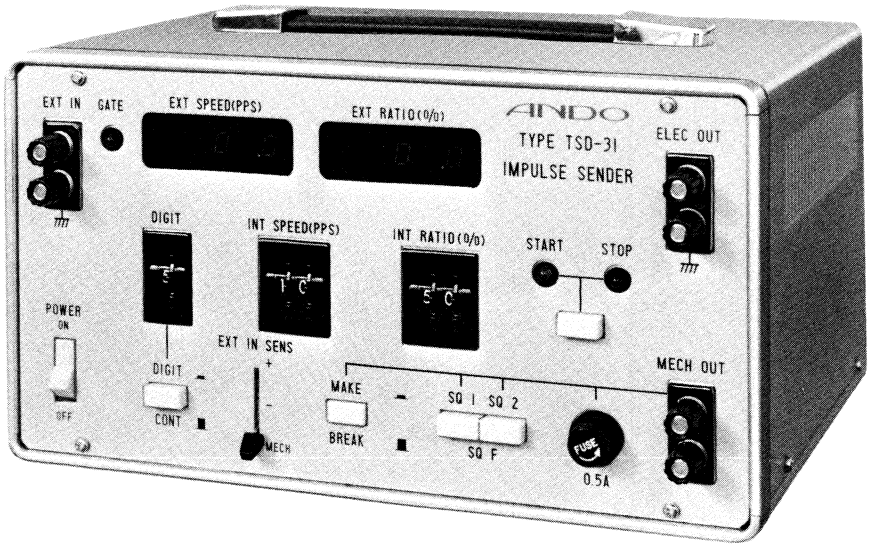
Dimensions: Approx. 200(H) x 350(W) x 450(D) mm (including cover)

Weight: Approx. 17 kg



On-line Monitoring Display (Full Duplex)

IMPULSE SENDER
TYPE TSD-31



The TSD-31 is a portable measuring instrument used in the performance tests on telephone sets, telephone exchanges and telephone circuits

The instrument has the following two functions:

1. Sending of impulse
2. Speed and make ratio measurements of external impulses

Owing to these functions, the instrument may be used separately as a test signal source or waveform tester.

With this instrument, it is also possible to examine the impulse transmission accuracy of telephone exchanges or circuits by sending impulses at the desired speed and make ratio and measuring the waveform of the signal looped back through the telephone exchange or circuit.

When two sets of this instruments are used, the end-to-end test can be done.

FEATURES

- The built-in crystal oscillator insures accurate impulse sendings.
- The digital thumb wheel switches employed permit easy settings of the speed and make ratio of impulses sent out.
- As to external impulses, the instrument can measure make ratio and speed as well.
- The instrument permits the measurement in an electrical input signal of 0 to −48V or 0 to +48V and also in a signal of −12V bias voltage from transistor relay circuit.
- The instrument permits the measurement in an input signal with chattering time of approximately up to 3ms.
- Easy-to-read, digital displays.
- The spark quenching circuit is provided to protect the relay contact against possible damage.

SPECIFICATIONS

Sent out impulses

Impulses: 1 to 10 or continuous.
Sending speeds: 1 to 39 pps in 1 pps steps.
Sending accuracy: Within ±0.2% for 1 to 30 pps.
Make ratio range: 1 to 99% in 1% steps.

External impulse measurement

Speed measurement range: 1 to 39 pps.
Speed measurement accuracy: Within ±0.1 pps for 1 to 30 pps.
Make ratio measurement range: 1 to 99%.
Make ratio measurement accuracy: Within ±0.1% for 5 to 95%.
Display: 3-digit numerical read-out.

General

Power requirements: 100V AC, 50/60Hz.
Dimensions: Approx. 150(H) x 280(W) x 200(D) mm.
Weight: Approx. 5.7kg.
Accessories supplied: Connecting cable (2m long), fuses.

MEASURING SETS FOR TELEPHONE SET

TYPE T-60NB SENSITIVITY MEASURING SET
TYPE R-60NB SENSITIVITY MEASURING SET
TYPE N-60NB SIDE-TONE ATTENUATION MEASURING SET

These measuring sets have been developed by modifying conventional measuring sets for Type 600 Telephone Set so as to permit measuring new telephone set (Type 601). Three models are available and designed to measure sensitivity, dynamic resistance and impedance of telephone sets at 1000Hz as well as side-tone attenuation of telephone networks.

From top in the photo
R-60NB
T-60NB
N-60NB

Instruments	Uses	Description
TYPE T-60NB SENSITIVITY MEASURING SET	Measurements of sensitivity and dynamic resistance at 1kHz on T-60, T-60L, T-62 and T-62L telephone transmitters.	Sensitivity measurement range: -65 to -44 dB. Dynamic resistance measurement range: 10 to 80Ω for T-60 (35Ω reference), 60 to 120Ω for T-60L and T-62L (80Ω reference), 30 to 90Ω for T-62 (55Ω reference). Power requirements: 100V AC, 50/60 Hz. Dimensions: Approx. 200 (H) x 350 (W) x 235 (D) mm.
TYPE R-60NB SENSITIVITY MEASURING SET	Measurements of sensitivity and impedance at 1kHz on R-60, R-60L, R-62 and R-62L telephone receivers.	Sensitivity measurement range: 60 to 80 dB. Impedance measurement range: 110 to 210Ω for R-60 (160Ω reference), 150 to 250Ω for R-60L and R-62L (200Ω reference), 220 to 420Ω for R-62 (320Ω reference). Power requirements: 100VAC, 50/60Hz. Dimensions: Mainframe, approx. 200 (H) x 350 (W) x 235 (D) mm; preamplifier, approx. 50 (H) x 200 (W) x 120 (D) mm.
TYPE N-60NB SIDE-TONE ATTENUATION MEASURING SET	Measurements of side-tone attenuation at 1kHz on N-60, N-60L, N-62, N-63, and N-63L telephone networks.	Attenuation measurement range: 10 to 55 dB Power requirements: 100V AC, 50/60Hz. Dimensions: Approx. 200 (H) x 350 (W) x 285 (D) mm.

VHF SIGNAL GENERATOR

TYPE GE-502

- *Frequency range from 455kHz to 129.999MHz*
- *FM/AM modulation capability*
- *Remote control operation of frequencies and output levels*
- *Suitable for both laboratory and production testings of FM/AM receivers*

The GE-502 VHF Signal Generator, a synthesized FM-AM signal generator used to measure the modulation characteristics of FM-AM receivers, covers a frequency range from 455 kHz to 129.999 MHz with output levels from −20 to +129 dBμ.

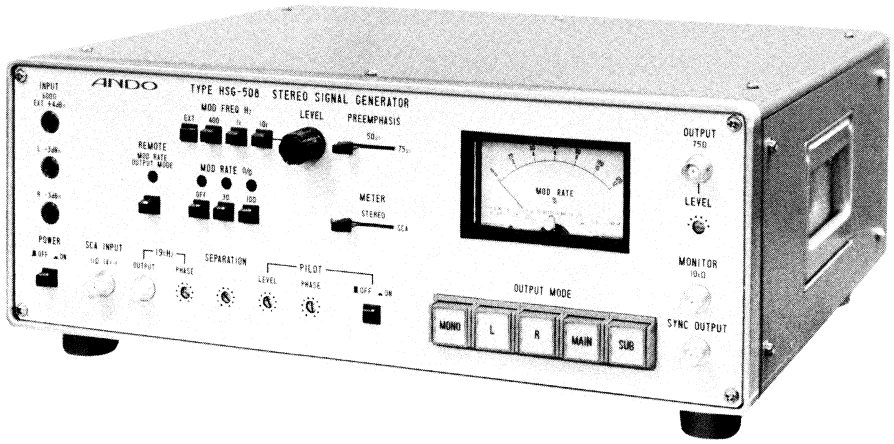
The GE-502 can provide complete stereo FM signals when used together with ANDO's HSG-508 Stereo Signal Generator, therefore it can be used for adjusting and testing IFs and VHF bands of FM stereo receivers. For details, see page 32.

STEREO SIGNAL GENERATOR

TYPE HSG-508

For designing, adjustment, testing, and maintenance of stereo receivers and transmitters.

- *It is easy to operate.*
- *It can be operated through remote control.*



The HSG-508 is a stereo signal generator for FM stereo broadcasting. It is used in combination with an FM signal generator (Ando's model recommended: Type GE-502 VHF Signal Generator) to measure the characteristics of stereo receivers, such as stereo separation, distortion, S/N ratio, and so forth. The HSG-508 with a balanced L-R input impedance of 600Ω can also be used as a stereo modulator for FM stereo broadcasting equipment.

EXCELLENT PERFORMANCE AND STABILITY

As the HSG-508 is designed to give long periods of high and stable performance in measurement of stereo separation, distortion, S/N ratio, and other characteristics of FM stereo receivers and transmitters, it needs little maintenance.

EASE OF OPERATION

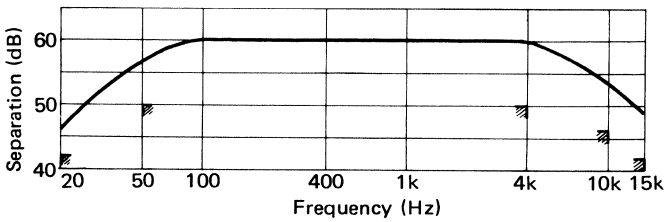
Large pushbuttons of momentary action are provided for signal selection so that the HSG-508 is ready to make accurate measurements at the mere touch of the switch. The rate of modulation can be set to 100%, 30% or 0% at the flick of a pushbutton.

OPERATION THROUGH REMOTE CONTROL

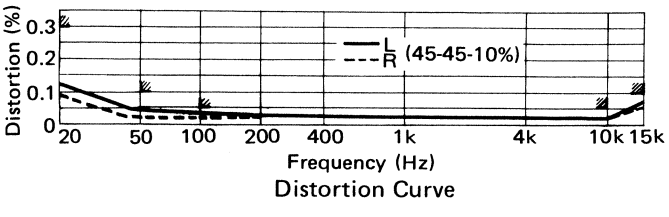
Signal generation and modulation for each channel can be remotely controlled by the use of such a sequencer as an external switch or a foot switch.

BUILT-IN LOW DISTORTION OSCILLATOR

A built-in low distortion oscillator which operates at 400Hz, 1kHz and 10kHz affords great convenience.



Stereo Separation Curve



Distortion Curve

Note: ▨ shows the HSG-508 specification.
— and - - - show measured data.

TYPE HSG-508, STEREO SIGNAL GENERATOR

SPECIFICATIONS

1. Input:

Input signals:	EXT OSC and L, R
Frequency range:	20Hz to 15kHz
Input impedance:	EXT OSC 600Ω unbalanced
	L, R 600Ω balanced
Input level:	EXT OSC +4dBm
	L, R −3dBm

2. Output:

Output signals:	Composite signal (Mono, L, R, MAIN, SUB) pilot signal
Output impedance:	75Ω unbalanced
Output level:	2Vp-p or more (at a terminal impedance of 75Ω)
Frequency response:	(1kHz reference)
	Within ±0.3dB from 50Hz to 10kHz
	Within ±0.5dB from 20Hz to 15kHz.
Stereo separation:	50dB or more from 50Hz to 4kHz
	46dB or more from 4 to 10kHz
	42dB or more from 20Hz to 15kHz.
Distortion:	(Mono, L and R output signals)
	0.05% or less from 100Hz to 10kHz
	0.1% or less from 50Hz to 15kHz.
	0.3% or less from 20 to 50Hz
S/N ratio:	80dB or more (measured at de-emphasis 50μs ON on stereo demodulator)
Pre-emphasis:	OFF, 50μs, 75μs
Output attenuator:	Variable from 0 to 20dB
Subcarrier suppression:	−50dB or less at an output of 2Vp-p

3. Internal Modulation Frequency Oscillator:

Frequencies:	400Hz, 1kHz, 10kHz

4. 19kHz output:

Frequency:	19kHz ±1.5Hz
Output level:	1Vp-p or more (at a load of 10kΩ or more)

5. SCA Input:

Frequency range:	59 to 75kHz
Input impedance:	Approx. 1kΩ
Input level:	1Vp-p

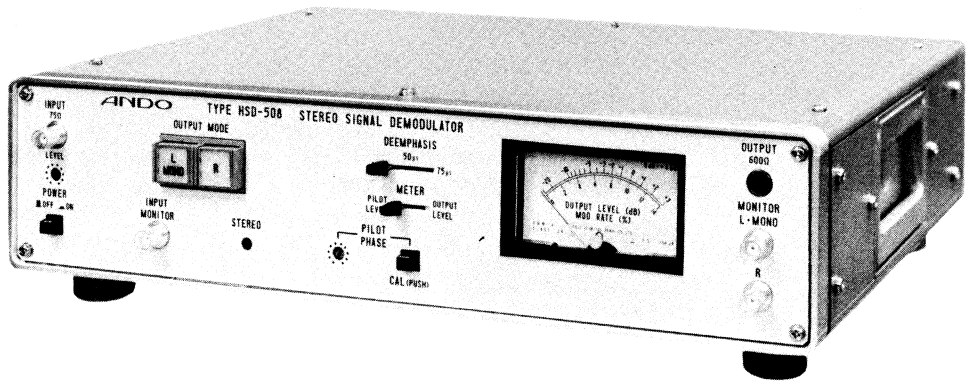
6. General:

Power requirements:	AC100V, 50/60Hz; approx. 30VA
Dimensions:	Approx. 150 (H) x 425 (W) x 300 (D) mm
Weight:	Approx. 8.5kg
Accessories supplied:	Input connecting cable x 3
	Output connecting cable x 2

STEREO SIGNAL DEMODULATOR

TYPE HSD-508

For maintenance and calibration of stereo signal generators and for designing, adjustment, and testing of FM stereo receivers and transmitters.
— With a Built-in Pilot Phase Calibration Circuit—



The HSD-508 is a stereo signal demodulator for testing and calibrating of stereo FM transmitters, modulators, and FM signal generators. As it has a built-in pilot phase calibration circuit, it is capable of calibrating the pilot signal phase without the aid of a standard stereo signal generator.
It needs little maintenance, for it is designed to give long periods of high and stable performance in measurement of stereo separation, distortion, S/N ratio, and other characteristics of FM stereo receivers and transmitters. When combined with the RDA-203, Ando's FM linear detector, the HSD-508 can also be used in designing and adjusting the high-frequency and IF circuits of FM receivers and transmitters.

EXCELLENT PERFORMANCE AND STABILITY

Stereo separation	50dB or more (50Hz to 4kHz)
Distortion	0.05% or less (100Hz to 10 kHz)
S/N ratio	Stereo, 83dB or more Mono, 86dB or more

BUILT-IN PILOT PHASE CALIBRATION CIRCUIT

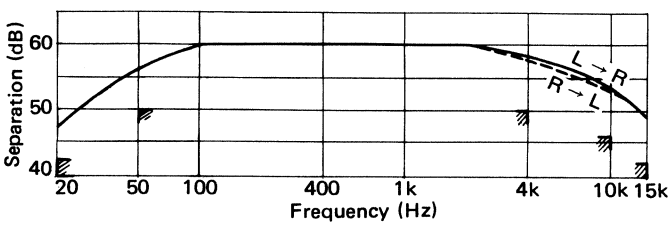
The built-in pilot signal phase calibration circuit makes accurate adjustments of the pilot signal phase without the aid of a standard stereo signal generator.

EASE OF OPERATION

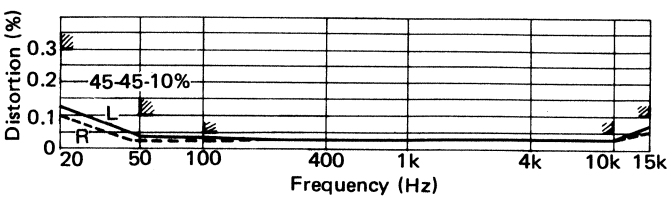
Large pushbuttons of momentary action are provided for signal selection so that the HSD-508 is ready to make accurate measurements at the flick of the switch.

L-R MONITOR OUTPUTS

L-R monitor outputs are provided.



Stereo Separation Curve



Distortion Curve

NOTE: ▨ shows the HSD-508 specification.
— and --- show measured data.

TYPE HSD-508, STEREO SIGNAL DEMODULATOR

SPECIFICATIONS

1. Input:

Input signals:	Mono and stereo
Frequency range:	Mono: 20Hz to 15kHz
	Stereo: 20Hz to 53kHz
Input impedance:	75Ω unbalanced
Input level:	1Vp-p

2. Output:

	Measuring output	Monitor output
Output signals	Mono Stereo signal demodulation output (L, R)	Mono Stereo signal demodulation output (L, R)
Frequency range	20Hz to 15kHz	20Hz to 15kHz
Output impedance	600Ω unbalanced	600Ω unbalanced
Output level	+4dBm	Approx. 2Vp-p (at 1kHz)
Frequency response	(1kHz reference) Within ±0.3dB from 50Hz to 10kHz Within ±0.5dB from 20Hz to 15kHz	
Separation	50dB or more from 50Hz to 4kHz 46dB or more from 4 to 10kHz 42dB or more from 20Hz to 15kHz	
Distoration	(Input signal: Mono or 45-45-10%) 0.05% or less from 100Hz to 10kHz 0.1% or less from 50Hz to 15kHz 0.3% or less from 20 to 50Hz	0.5% or less from 100Hz to 10kHz
S/N ratio	Stereo: 83dB or more (at de-emphasis 50μs or 75μs ON) Mono: 86dB or more (at de-emphasis 50μs or 75μs ON)	80dB or more (at 1kHz with de-emphasis 50μS or 75μS ON)
De-emphasis	OFF, 50μs, 75μs	50μs, 75μs

3. General:

Power requirements:	AC 100V, 50/60Hz; approx. 20VA
Dimensions:	Approx. 100(H) x 425 (W) x 300 (D) mm
Weight:	Approx. 7kg
Accessories supplied:	Input connecting cable x 1
	Output connecting cable x 4

FM LINEAR DETECTORS

TYPES RDA-203/204/206

RDA-203: 7 to 1000MHz.
Residual AM measurement capability.
RDA-204: 7 to 1000MHz.
RDA-206: 7 to 520MHz.

TYPE RDA-203

The RDA-203/204/206 are standard FM modulation meters which are used in the determination of modulation characteristics of FM multiplex transmitters (FM stereo transmitters, mobile radio transmitters, etc.) and TV aural transmitters. They are universal FM modulation meters which find use in wide applications including collection and analysis of technical data for designing and prototype manufacture of multiplex transmitters and signal generators, as well as calibration and testing of such appliances.
The RDA-204 is same as the RDA-203 except residual AM measurement capability.

TYPE RDA-204

TYPE RDA-206

FEATURES

1. Low distortion
   The distortion of the demodulation circuit is as low as 0.1% in the frequency range of from 50 Hz to 60 kHz.
2. Stable S/N ratio measurement
   The local oscillator employs a variable inductance circuit so that the influence of external vibrations is minimized.
3. Excellent L/R separation
   The RDA series is excellent in L/R separation of FM stereo signals because of good phase characteristics.
4. High output level
   The output level is as high as +10 dBm, when a full scale reading is given on the modulation indicator.
5. Interface with an external local oscillator
   Since the RDA series is so designed as to have an interface with an external local oscillator, the precision of its S/N ratio measurement can be greatly increased by the use of a quartz oscillator or the like and it can also make rapid measurements of multichannel wireless installations.
6. Residual AM measurement (RDA-203 only)
   The RDA-203 is capable of measuring the residual AM level necessary to test FM broadcasting transmitters.

TYPES RDA-203/204/206, FM LINEAR DETECTORS

SPECIFICATIONS

Type			RDA-203	RDA-204	RDA-206
Input frequency range			7 to 1000MHz in 7 ranges		7 to 520MHz in 5 ranges
Input impedance			50Ω unbalanced		50Ω unbalanced
Input level (terminated)			100 to 126 dBμ, 7 to 520MHz 110 to 126 dBμ, 520 to 1000MHz		100 to 126 dBμ
FM	Deviation range		0 to ±2 / 5 / 10 / 20 / 50 / 100 / 200kHz		
	Indication		Peak indication; -P, +P, $\frac{P-P}{2}$		
	Accuracy		±3% of full scale (demodulation frequency, 30Hz to 200kHz)		
Residual AM	Deviation range		-70 to -50 / -40 / -30 dB	———	———
	Indication		Peak indication		
	Accuracy		±5% of full scale		
Demodulation frequency		FM	10Hz to 200kHz		
		Residual AM	30Hz to 50kHz	———	———
Band limit filter			HPF: THRU / 0.05 / 0.3 / 3.8kHz LPF: 3.6 / 17 / 135 / 300kHz		
De-emphasis			50μs, 75μs and OFF		
Output impedance			600Ω balanced / 75Ω unbalanced		
Output level			+10 dBm ±0.5 dB (full scale)		
Frequency response			600Ω balanced: ±0.2 dB, 30Hz to 15kHz (1kHz reference) 75Ω unbalanced: ±0.2 dB, 10Hz to 200kHz (1kHz reference)		
Distortion			0.1% or less, 50Hz to 60kHz; 0.3% or less, 10Hz to 200kHz (±100kHz deviation, +10 dBm output)		
L/R separation			46 dB or more, 100Hz to 10kHz; 40 dB or more, 50Hz to 15kHz		

Signal-to-noise ratio		Use	Deviation	Demodulation band width	Input frequency (MHz) 7 to 230	Input frequency (MHz) 230 to 520 for RDA-206, 230 to 1000 for RDA-203/204
		Multiplexed radio communication	±100kHz	10Hz to 135kHz	70dB or more	65dB or more
	Broadcasting	FM monophonic	±75kHz	10Hz to 135kHz (50/75μs de-emphasis ON)	75dB or more	70dB or more
		FM stereophonic		10Hz to 135kHz	68dB or more	63dB or more
		TV aural	±25kHz	10Hz to 17kHz (75μs de-emphasis ON)	65dB or more	60dB or more
				10Hz to 17kHz	63dB or more	58dB or more
		Mobile radio communication	±3.5kHz	300Hz to 3.6kHz	55dB or more	50dB or more
		(RDA-203 only) Residual AM (Modulation depth: -30dB)		30Hz to 135kHz	50dB or more	40dB or more

Power requirements	AC100V, 50/60Hz; approx. 30VA or external DC -25 to -20V, approx. 300mA; +20 to +25V, approx. 600mA.
Dimensions & weight	Approx. 150(H) x 425(W) x 300(D) mm; approx. 15kg
Accessories supplied	Three cables, three terminals (for DC), one fuse.

MEASURING SYSTEM FOR STEREOPHONIC FM BROADCASTING

TYPE HSE-502

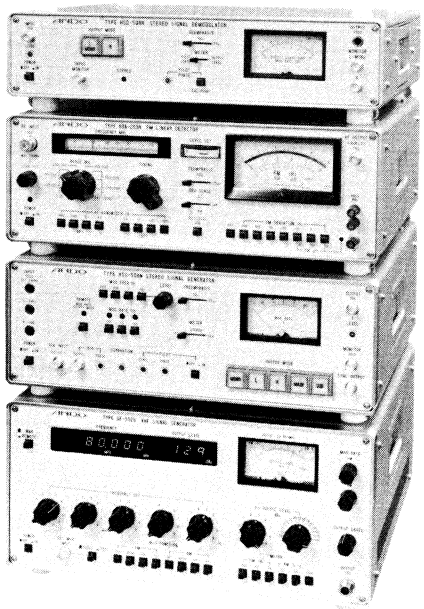
The HSE-502 is a composite measuring system suitable for measuring the stereo characteristics on tuners, transmitters, and relay transmitters for FM broadcasting.

The system consists of (from top in the photo):

HSD-508 Stereo Signal Demodulator (see page 160)
RDA-203 FM Linear Detector (see page 162)
HSG-508 Stereo Signal Generator (see page 158)
GE-502 VHF Signal Generator (see page 32)

Condensed specifications are as follows.

Carrier wave frequency: 76 to 108 MHz and IF.
Frequency response: ±0.3 dB (100 Hz to 10 kHz); ±0.5 dB (30 Hz to 15 kHz).
S/N: 68 dB (measured data, 72 dB).
Harmonic distortion: 0.1% (100 Hz to 10 kHz).
L/R separation: 46 dB (100 Hz to 10 kHz).



MEASUREMENTS

Measuring items		Measuring sets used				Complementary instruments required *
		GE-502	HSG-508	HSD-508	RDA-203	
For transmitter	Maximum frequency deviation	–	Yes	–	Yes	Modulation index meter, oscilloscope
	Modulation frequency characteristics	–	Yes	Yes	Yes	Level meter
	Modulation distortion	–	Yes	Yes	Yes	Distortion meter
	S / N	–	Yes	Yes	Yes	Level meter
	L/R separation degree	–	Yes	Yes	Yes	Level meter
	Level difference between L and R signals	–	Yes	Yes	Yes	Level meter
	Phase of pilot signal	–	Yes	–	Yes	Oscilloscope
	Stereo subcarrier suppression ratio	–	Yes	–	Yes	Oscilloscope
	Main carrier-frequency deviation caused by pilot signal	–	Yes	–	Yes	Oscilloscope
	Polarity of L, R and pilot signals	–	Yes	–	Yes	Oscilloscope
For relay transmitter-receiver	D / U characteristics	Yes * *	Yes	Yes	Yes	Oscilloscope, Level meter
	Modulation frequency characteristics	Yes	Yes	Yes	Yes	Level meter
	Modulation distortion	Yes	Yes	Yes	Yes	Distortion meter
	S / N	Yes	Yes	Yes	Yes	Level meter
	L / R separation degree	Yes	Yes	Yes	Yes	Level meter
For receiver	S / N	Yes	Yes	–	–	Level meter
	Effective selectivity	Yes * *	–	–	–	Level meter
	Image interference ratio	Yes	–	–	–	Level meter
	Demodulated frequency characteristics	Yes	Yes	–	–	Level meter
	Distortion	Yes	Yes	–	–	Distortion meter
	L / R separation degree	Yes	Yes	–	–	Level meter

* : In every measurement, an oscillator having the frequency coverage of over 20Hz to 15kHz is necessary as an signal source.

* * : Two sets of GE-502 are required.

TERMINATION LOAD POWER METERS

TYPES DPC-10/11/12/14

- *DC–500MHz portable UHF power meters*

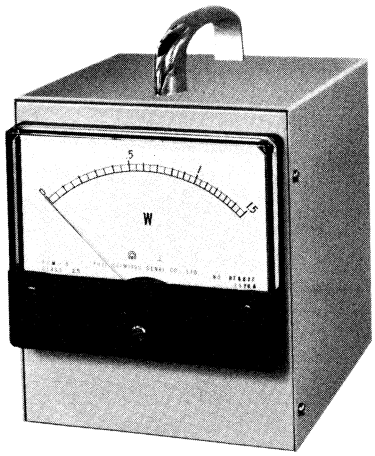
  Measurement range

  DPC-10····· 15W

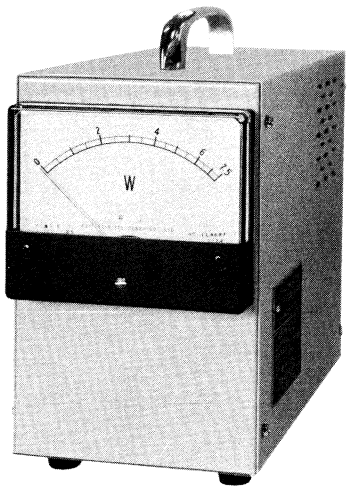
  DPC-11····· 30W

  DPC-12····· 1.5W

  DPC-14····· 7.5W



TYPE DPC-12



TYPE DPC-14

13

SPECIFICATIONS

Type	DPC-10	DPC-11	DPC-12	DPC-14
Frequency range	DC to 500 MHz			
Measurement power	15W (one range)	30W (one range)	1.5W (one range)	7.5W (one range)
Accuracy	Within ±10% of full scale			
Impedance	50Ω unbalanced			
VSWR	1.2 or less			
Input terminal	N type, female			
Dimensions (HxWxD) mm	Approx. 165 x 105 x 160	Approx. 165 x 105 x 160	Approx. 125 x 105 x 125	Approx. 165 x 105 x 160
Weight	Approx. 1.6 kg	Approx. 1.8 kg	Approx. 1.3 kg	Approx. 1.6 kg

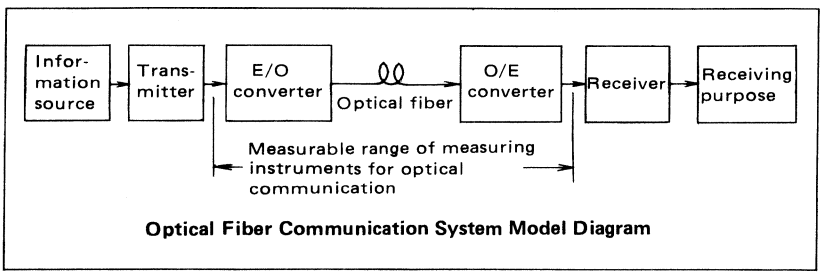
14 OPTICAL COMMUNICATIONS MEASURING SETS

GENERAL INFORMATION

OPTICAL FIBER COMMUNICATION SYSTEM

Since the optical fiber communication system features a number of advantages as compared with conventional metal cable communication system, its technique has been attracting a good deal of attention all over the world in recent years. This communication system transmits data through "(electro-optical converter) + (optical fiber cable) + (optical-electro converter)" instead of conventional metal cable as illustrated below (Fig. 1), and it allows long-distance non-repeated transmission and large-capacity transmission owing to the invention of laser and low-loss design of fiber.

ANDO has been manufacturing and selling optical power meters, while taking notice of the future prospect of this optical communication since 1973, and has recently developed measuring instruments to allow tests of various measuring items within the measurable range illustrated below, such as characteristics of fiber in the wavelength region, transmission characteristics in baseband, and others, as a comprehensive instruments maker in the optical fiber communication system so as to meet increasing demands in recent years.



Optical Fiber Communication System Model Diagram

Fig. 1

WAVELENGTH RANGE IN OPTICAL FIBER COMMUNICATION SYSTEM

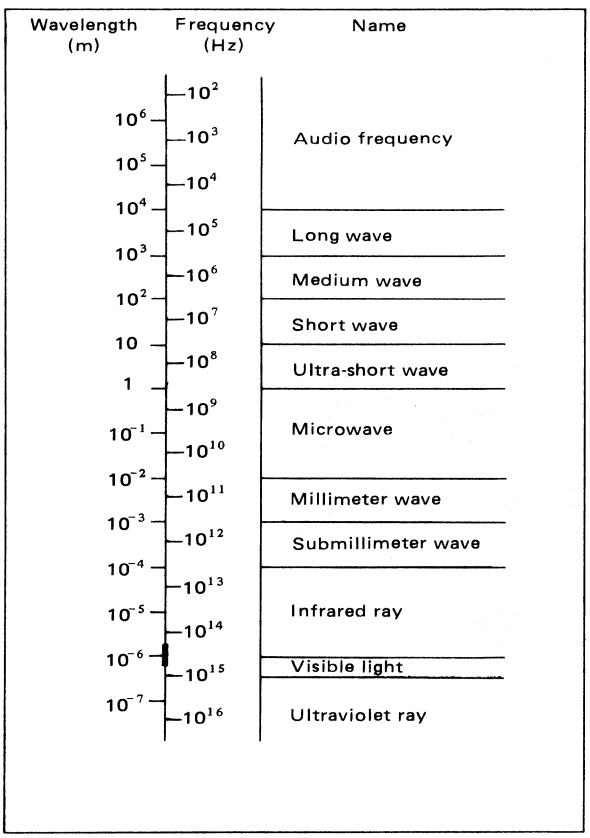


Fig. 2

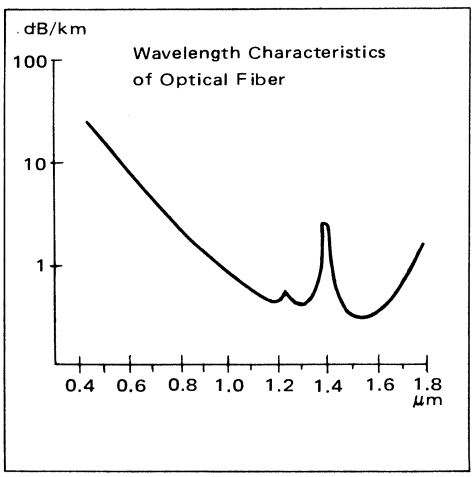


Fig. 3

The kinds and nominations of electromagnetic waves are shown in Fig. 2. The optical fiber shows a low loss from the near-infrared (0.76 to 1.3μm) range to the far-infrared (more than 1.3μm) range. Fig. 3 shows an example of the wavelength characteristics of the optical fiber. A noticeable loss around 1.4μm is caused by the OH-radical absorption, and it scarcely remains when the OH radical is eliminated. Thus, the optical fiber is shiftable to a longer wavelength range.

ANDO has a large assortment of product groups covering an extensive wavelength range from the visible light to the far-infrared ray.

TYPICAL MEASURING SYSTEMS OF OPTICAL FIBER COMMUNICATIONS

LOSS MEASUREMENT

For accurate loss measurement, enhance stability of the light source, and use the optical power meter on the receiving side. For further precision measurement, use the dummy fiber, mode scrambler, and mode cutter to eliminate the clad mode, etc. Chop the light source, and use the AQ-1113 on the receiving side for noticeable loss measurement. (Fig. 4)

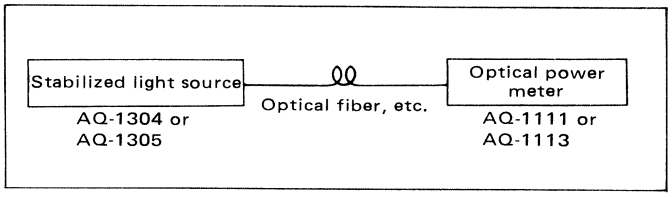


Fig. 4

LOSS WAVELENGTH CHARACTERISTICS MEASUREMENT

In order to facilitate far-end measurement, the white light source and monochromator are divided to directly input the white light source output to fiber, and the wavelengths are selected by the monochromator on the receiving side as shown in Fig. 5

In order to spread the dynamic range, the light source is chopped and the chopped signal is AC-amplified to increase sensitivity on the receiving side in any case.

In order to perform accurate measurements by using these instruments, the measuring system must be calibrated using a short-length fiber. Then, connect the fiber to be measured, and measure it. The difference from the previous reference signal is obtained as a fiber loss.

Since this measurement requires complicated operation and considerable time, automatic measurement using CPU control is recommendable. Since the AQ-1301, AQ-1210, AQ-1113, etc. are controllable by GP-IB, an automatic measurement system can easily be established by connecting a suitable controller. ANDO's desktop computers amics 80 (models AE-8101, 8102, 8103) are recommendable as these controllers. Fig. 5 shows an example of measurements using the amics 80 system.

Fig. 6 shows an example for wavelength characteristic curve.

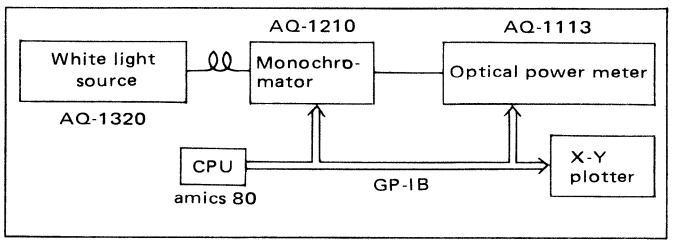


Fig. 5

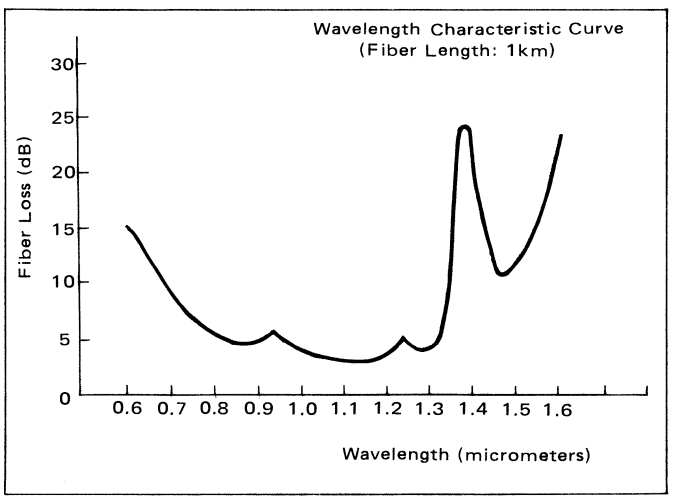


Fig. 6

LIGHT SOURCE MEASUREMENT

The light source power can easily be measured by using the optical power meter. ANDO's optical power meter is provided with an adapter convenient for various measurements such as connector connection, output light of bare fiber, spatial propagation light, etc. (Fig. 7)

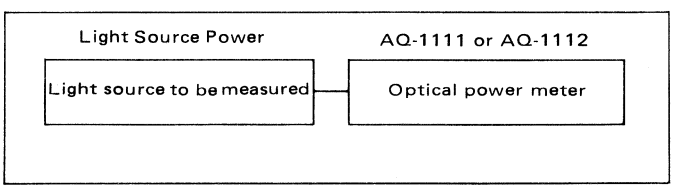


Fig. 7

OPTICAL POWER METER
TYPE AQ-1111

GP-IB

For optical and laser power measurements
- *Three different display modes selectable: W, dBm, dB*
- *GP-IB capability (option) for an automatic measurement system use*

The AQ-1111 is a portable, general-purpose optical power meter used for measuring optical and laser power. It is composed of a mainframe and a sensor (sensors). Two models of sensors are selectable according to wavelength: a silicon photo diode sensor for short wavelength (600 to 1100nm) and a germanium photo diode sensor for long wavelength (1000 to 1700nm). Options include a GP-IB card, a bare fiber adapter, a connector adapter, and a DC battery unit for an exclusive use. The GP-IB card facilitates a complete automatic measurement. The bare fiber adapter and connector adapter permit easy measurements of optical power transmitted through a optical fiber cable, and thus, efficient measurements are assured. The DC battery unit is a convenient tool for outdoor use.

USES
- Minute level measurements of optical and laser power.
- Automatic measurement system use.

FEATURES
- Three different display modes are selectable: watt (W), absolute level (dBm), and relative level (dB).
- The relative level to the reference value can be measured.
- Average processings of measurements are selectable in three ranges: 1, 10, and 100 times.
- AUTO OFFSET button is provided.
- GP-IB remote control capability for an automatic measurement system use.
- Can be operated from either AC or external DC. A DC battery is available as an option for outdoor use — one of user convenience.
- Small in size and light in weight.

TYPE AQ-1111, OPTICAL POWER METER

SPECIFICATIONS

Power level measuring range	−70 dBm to +10 dBm/0.1nW to 10mW (Si sensor) −50 dBm to +5 dBm/10nW to 3mW (Ge sensor)
Wavelength range	600nm to 1100nm (Si sensor), 1000 nm to 1700nm (Ge sensor)
Resolution	0.01dB or 0.1 to 1%
Accuracy	Within ±5% (Si sensor: at 0.85μm, Ge sensor: at 1.3μm)
Sensor	Silicon photo diode (wavelength: 600nm to 1100nm) Germanium photo diode (wavelength: 1000nm to 1700nm)
Display	4-digit digital display
Functions	Range: Auto-ranging (range-hold function is also provided) Display: dBm, dB (relative measurement to reference measuring value) and W Wavelength sensitivity calibration: External setting, one point; internal setting, two points Auto zero set: Automatic zero setting Status: "OVER" and "UNDER" display to set range Averaging processing: Settable in three ranges of 1, 10 and 100 times
Output	Analog output: 0 to approx. 2V (in each range) Impedance: Lower than 1kΩ
Typical characteristics of sensors	When using silicon photo diode sensor: Fig. 1 on page 176. When using germanium photo diode sensor: Fig. 2 on page 176.
Power requirements	100V AC, 50/60Hz or external battery (option, rechargeable)
Dimensions and weight	Approx. 75(H) x 210(W) x 200(D) mm, approx. 2.8kg.
Options	GP-IB card, connector adapter, bare fiber adapter, AP-2602 battery (rechargeable).

With AD-2602 battery option

STANDARD OPTICAL POWER METER

TYPE AQ-1112

GP-IB

For optical and laser power calibration

- *0.01dB fine resolution*
- *± 2% high accuracy*

The AQ-1112 is a dependable, high-precision standard optical power meter designed for optical and laser power calibration. It consists of a mainframe and a sensor unit. Since a thermopile mount featuring reduced wavelength dependency is employed as the sensor, this instrument can be used over a wide wavelength range. An automatic measurement is possible with GP-IB interface card (option) combined.

USES

- Light source output calibration
- Usable as a secondary standard for various optical power meters.

FEATURES

- ±2% high accuracy
- 0.01dB fine readout resolution
- Applicable over a wide wavelength range from 600 to 1700nm (reduced wavelength dependency)
- AUTO OFFSET button is provided.
- Three different display modes are selectable: watt (W), absolute level (dBm), and relative level (dB).
- The relative level to the reference value can be measured.
- Average processings of measurements are selectable in three ranges: 1, 10 and 100 times.
- GP-IB remote control capability for an automatic measurement system use.
- Can be operated from either AC or external DC. A DC battery is available as an option.

TYPE AQ-1112, STANDARD OPTICAL POWER METER

SPECIFICATIONS

Power level measuring range	−20 dBm to +10 dBm/10μW to 10mW
Wavelength range	600nm to 1700nm
Resolution	0.01dB or 0.1 to 1%
Accuracy	Within ±2% (25°C ±10deg, at 0 dBm)
Sensor	Thermopile (wavelength: 600nm to 1700nm)
Display	4-digit digital display
Functions	Range: Auto-ranging (range-hold function is also provided) Display: dBm, dB (relative measurement to reference measuring value) and W Auto zero set: Automatic zero setting Status: "OVER" and "UNDER" display to set range Averaging processing: Settable in three ranges of 1, 10 and 100 times
Output	Analog output: 0 to approx. 2V (in each range) Impedance: Lower than 1kΩ
Typical characteristics of sensor	See Figure 5 on page 176
Power requirements	100V AC, 50/60Hz or external battery (option, rechargeable)
Dimensions and weight	Approx. 75(H) x 210(W) x 200(D) mm, approx. 2.8kg (mainframe)
Options	GP-IB card, connector adapter, bare fiber adapter, AP-2602 battery (rechargeable)

CHOPPED LIGHT POWER METER

TYPE AQ-1113

GP-IB

For high-sensitive chopped light power measurements

- *GP-IB capability (option) for an automatic measurement system use*
- *No offset is required*

The AQ-1113 Chopped Light Power Meter can make an extremely small power measurement by measuring the chopped light which was chopped at 270Hz.

The standard configuration includes a mainframe and a sensor. Two models of sensors are selectable according to wavelength: a silicon photo diode sensor for short wavelength (600 to 1100nm) and a germanium photo diode sensor for long wavelength (1000 to 1700nm). The extremely small power measurement (high-sensitive measurement) can be also made without an optical chopper option when the AQ-1304 (or the AQ-1317) LED Ligh Source or the AQ-1318 (or the AQ-1305) LD Light Source is used together with the AQ-1113.

Many options are available: a GP-IB card, a bare fiber adapter, a connecter adapter, and a DC battery unit for an exclusive use. The GP-IB card facilitates a complete automatic measurement. The bare fiber adapter and connector adapter permit easy measurements of optical light power transmitted through a optical fiber cable, and thus, efficient measurements are assured. The DC battery unit is a convenient tool for outdoor use.

USES

- Suitable for extremely small power measurements
- Automatic measurement system use

FEATURES

- High-sensitive measurement because chopped light measuring method is employed.
- AUTO OFFSET button is provided.
- High-sensitive measurement of continuous wave (CW) light can be made with an optical chopper option combined.
- Three different display modes are selectable: watt (W), absolute level (dBm), and relative level (dB).
- The relative level to the reference value can be measured.
- Average processings of measurements are selectable in three ranges: 1, 10, and 100 times.
- GP-IB remote control capability for an automatic measurement system use.
- Can be operated from either AC or external DC. A DC battery is available as an option for outdoor use.

TYPE AQ-1113, CHOPPED LIGHT POWER METER

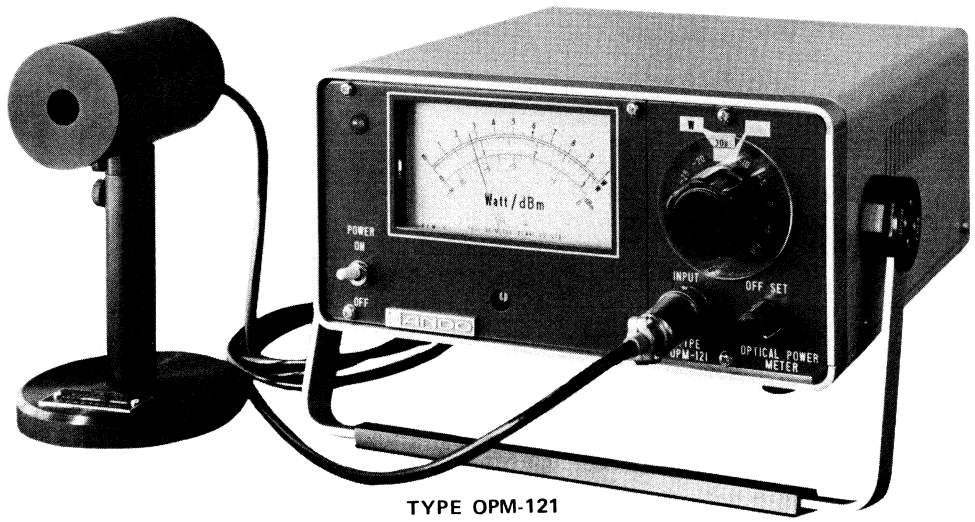
SPECIFICATIONS

Power level measuring range	−80 dBm to 0 dBm (0.85μm band), 270Hz 50% duty square wave modulated light −70 dBm to 0 dBm (1.3μm band), 270 Hz 50% duty square wave modulated light
Wavelength range	600nm to 1100nm (Si sensor), 1000nm to 1700nm (Ge sensor)
Resolution	0.01dB or 0.1 to 1%
Accuracy	Within ±5% (Si sensor: at 0.85μm, Ge sensor: at 1.3μm)
Sensor	Silicon photo diode (wavelength: 600nm to 1100nm) Germanium photo diode (wavelength: 1000nm to 1700nm)
Display	4-digit digital display
Functions	Range: Auto-ranging (range-hold function is also provided) Display: dBm, dB and W Wavelength sensitivity calibration: External setting one point, internal setting two points Status: "OVER" and "UNDER" display to set range Averaging processing: Settable in three ranges of 1, 10 and 100 times Relative level measurement (dB)
Output	Analog output: 0 to approx. 2V (in each range) Impedance: Lower than 1kΩ
Typical characteristics of sensors	When using silicon photo diode sensor: Fig. 1 on page 176. When using germanium photo diode sensor: Fig. 2 on page 176.
Power requirements	100V AC, 50/60Hz or external batteries (option, rechargeable)
Dimensions and weight	Approx. 75(H) x 210(W) x 200(D) mm, approx. 2.8 kg
Options	GP-IB card, connector adapter, bare fiber adapter, AP-2602 battery (rechargeable), optical chopper

OPTICAL POWER METERS

TYPES OPM-120/121/122/123/124B

Analog meter type



TYPE OPM-121

SPECIFICATIONS

Type	OPM-120	OPM-121	OPM-122	OPM-123	OPM-124B
Use	• For extremely low level measurements	• For low level measurements (excellent in wavelength sensitivity)	• For power level standard (DC calibration capability provided)	• For midium level measurements • For power level standard	• For high level measurements • For power level standard
Measurement range	1nW to 3mW (−60 to +5dBm) Small level down to 0.1nW detectable 12 ranges	10nW to 10mW (−50 to +10dBm) 12 ranges	100μW to 10mW (−10 to +10dBm) 4 ranges	10mW to 1W (+10 to +30dBm) 4 ranges	100mW to 10W (+20 to +40dBm) 4 ranges
Wavelength range	450 to 1100nm (wavelength characteristics are not corrected; max. sensitivity at 850nm)	380 to 1150nm (flat at 450 to 950 nm)	350nm to 10.6μm	350nm to 10.6μm	350mm to 10.6μm
Resolution	3 to 5% or 0.2 to 0.5dB of reading				
Accuracy	±5% at 632.8nm	±5% at 632.8nm	±5% (0.1 to 0.5 mW) ±2% (0.5 to 10 mW) at 632.8 nm	±5% at 514.5nm	±5% at 514.5nm
Sensors	Silicon photo diode		Thermopile		
Active area	44mm² (7.5mmϕ)	1 cm² (11.3mmϕ)	12.6 mm² (4mmϕ)	50.3 mm² (8mmϕ)	3.14cm² (20mmϕ)
Output	Approx. 10V at max. deflection on each meter range; output impedance, 1kΩ or less				
Typical characteristics of sensors	See Figures on page 176				
	Fig. 4	Fig. 3	Fig. 5	Fig. 5	Fig. 5
Power requirements	100V AC, 50/60Hz; approx. 10VA				
Dimensions and weight	Main unit, approx. 100(H) x 210(W) x 200(D) mm, approx. 3 kg				
Other functions	1. Range setting: Manual 2. Meter indication: Watts and decibels 3. Wavelength sensitivity can be corrected. External setting: one position. Internal settings: three positions of A, B, C — the position A is calibrated at each wavelength described in the accuracy of the above column. The characteristics of the positions B and C are almost the same as that of the position A. 4. Off-set is possible.				
Accessories supplied	One spare fuse.				

OPTICAL POWER TESTERS

TYPES AQ-1130/1170

● *Built-in battery operated*

TYPE AQ-1130

TYPE AQ-1170

SPECIFICATIONS

Type	AQ-1130	AQ-1170
Use	For low level measurements, pocket-size	
Measurement range	100 nW to 3 mW (-40 to +5 dBm) 10 ranges	100 nW to 10 mW (-40 to +10 dBm) 11 ranges
Wavelength range	450 to 1100 nm (wavelength characteristics are not corrected; max. sensitivity at 850 nm)	
Resolution	2 to 10% or 0.5 dB of reading	
Accuracy	±10% at 632.8 nm	±5% at 632.8 nm
Sensor	Silicon photo diode (option)	
Active area	Type A: 44 mm^2 (7.5 mmϕ), Type B: 254 mm^2 (18 mmϕ)	
Indication	Watts and dBm on meter	
Typical characteristics of sensor	See Fig. 4 on page 176	
Power requirements	Batteries (UM-5x4) (6V)	Batteries (UM-3x4) (6V)
Dimensions	Approx. 125(H) x 75(W) x 31(D) mm	Approx. 160(H) x 115(W) x 72(D) mm
Weight	Approx. 0.5 kg	Approx. 1.5 kg
Other functions	Battery check available AQ-1170: Wavelength sensitivity can be corrected with SELECT switch – three positions A, B, C Position A: calibrated at 632.8 nm Position B: calibrated at approx. 850 nm Position C: the same as position A	
Options	Type A sensor, Type B sensor, stand (for Type A sensor)	

OPTICAL POWER METERS/TESTERS

TYPICAL CHARACTERISTICS OF SENSORS

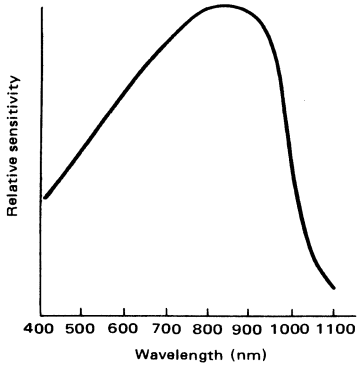


Fig. 1

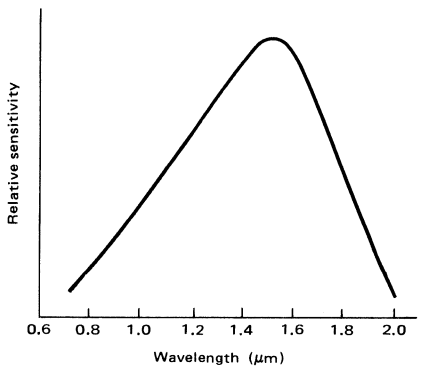


Fig. 2

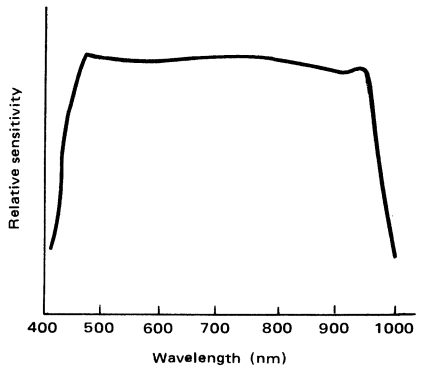


Fig. 3

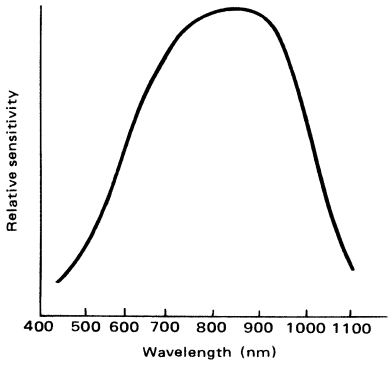


Fig. 4

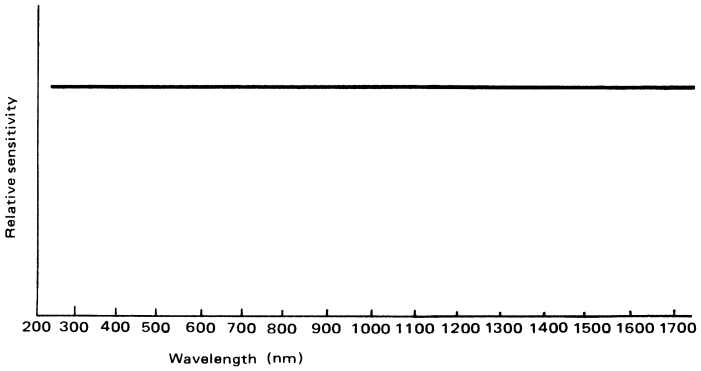
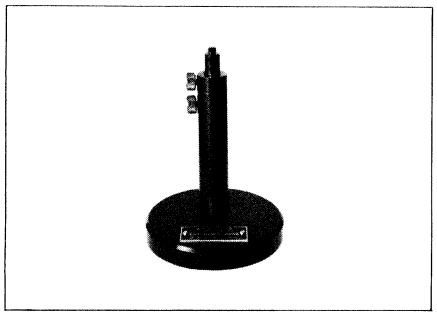
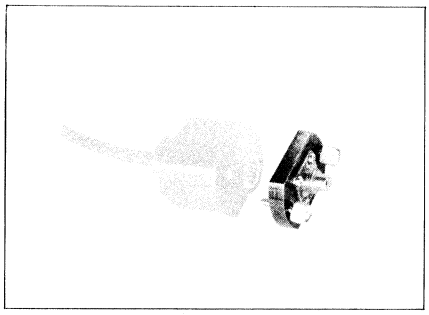


Fig. 5

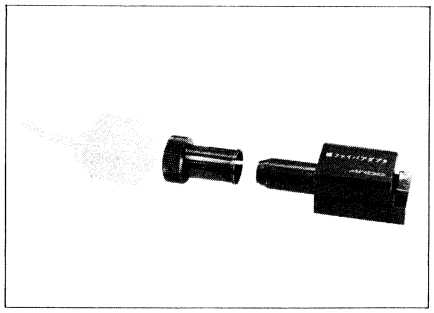
OPTICAL POWER METER OPTIONS



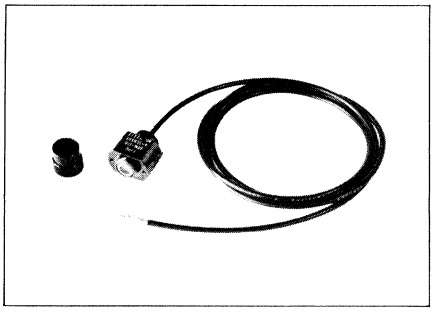
HEAD STAND



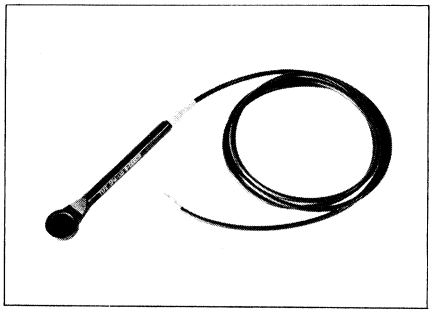
CONNECTOR–ADAPTER



BARE FIBER-ADAPTER



TYPE A SENSOR



TYPE B SENSOR

E/O, O/E CONVERTERS

Optical Fiber Base Band Transmission Measurement

The most basic tests for evaluation of optical fibers are:

(a) Optical fiber wavelength loss characteristics measurement

(b) Base band transmission characteristics measurement

The former test is performed so as to determine the attenuation of the power of light propagated through an optical cable relative to the wavelength of light. The latter test is performed in order to determine the effect of the difference in group velocity in light propagation through an optical cable; this difference in group velocity of light is a limitation on the envelope band of intensity modulated waves of propagated light.

The E/O and O/E converters described in this catalog are for use in base band transmission measurements. The base band transmission measurements are made by two methods:

(a) Pulse method

(b) Frequency sweep method

The pulse method is employed in the observation of the waveform of pulses received after propagation of an intensity modulated wave envelope in sharp pulses through an optical cable. In this case the transmission characteristics are evaluated by measuring the pulse waveform or Fourier's conversion of pulse waveform distortion.

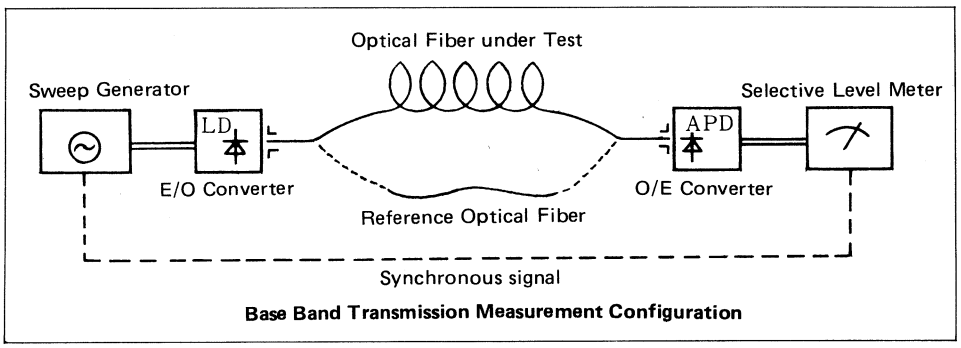
The frequency sweep method, on the other hand, consists of frequency sweeping of light modulated to a sine wave. This method has the advantages of an excellent S/N ratio and freedom from the nonlinear influence of light-emitting elements and photocells.

E/O and O/E Converters

The E/O and O/E converters described in this catalog are used with oscillators, level meters or other measuring instruments when making base band transmission measurements by the frequency sweep method. They convert electrical signals to optical ones and vice versa.

In the AQ-1310 E/O Converter the LED is used as the light source for relative slow modulation of light waves and in the AQ-1311 E/O Converter semiconductor laser is used as the light source for fast modulation of light waves.

On the other hand, the avalanche photodiode is used in the AQ-1401 O/E Converter as a high sensitivity photocell for observation of ultra-low power optical signal waveforms, and the PIN photodiode is used in the AQ-1411 O/E Converter for observation of optical signal waveforms.



Base Band Transmission Measurement Configuration

E/O CONVERTERS
TYPES AQ-1310/1311

The AQ-1310/1311 E/O Converters are base band modulation electro-optical converters to convert an electric signal into an optical signal. The AQ-1310 E/O Converter employs an LED (light-emitting diode) as the light source and its modulation frequency band is 100kHz to 110MHz.

The AQ-1311 E/O Converter employs an LD (laser diode) as the light source, and its modulation frequency band is 1MHz to 1000MHz. Thus, it permits the base band modulation over a wide range. These converters allow efficient measurements of the base band characteristics of the optical fiber and other optical devices in the optical communication, etc. with ANDO's AQ-1401/1411 O/E Converters combined.

Since these converters are compact, they can easily be combined with measuring instruments in the base band.

TYPE AQ-1310

TYPE AQ-1311

SPECIFICATIONS

Type	AQ-1310	AQ-1311
Use	Base band characteristics measurement of optical devices	
Optical output wavelength	Approx. 850nm	
Optical output level	Approx. -20dBm or more (input for GI fiber)	Approx. -10dBm or more (input for GI fiber)
Base band	100kHz to 110MHz	1 to 1000MHz
Base band deviation	Approx. 3dB (with AQ-1411 combined)	Approx. 6dB (with AQ-1411 combined)
Base band input level	0 dBm or less	
Base band input impedance	75Ω unbalanced	
Input connector	SP	
Output connector	D3	
Power requirements	100V AC, 50/60Hz; approx. 20VA	
Dimensions	Approx. 75(H) x 140(W) x 150(D) mm	
Weight	Approx. 2kg	
Accessories supplied	One fuse	

O/E CONVERTERS
TYPES AQ-1401/1411

The AQ-1401/1411 O/E Converters are base band demodulation optical-electro converters to convert an optical signal into an electric signal.

The AQ-1401 O/E Converter employs Si-APD (silicon avalanche photo-diode) as the light receiver, and its demodulation frequency band is 1MHz to 1000MHz.

The AQ-1411 O/E Converter employs Si-PIN photo-diode and its demodulation frequency band is 1MHz to 1000MHz. It is mainly used for waveform observation.

These converters allow efficient measurements of the base band characteristics of the optical fiber and other optical devices in the optical communication, etc., with ANDO's AQ-1310/1311 E/O Converters combined.

Since these converters are compact, they can easily be combined with measuring instruments in the base band.

TYPE AQ-1401

TYPE AQ-1411

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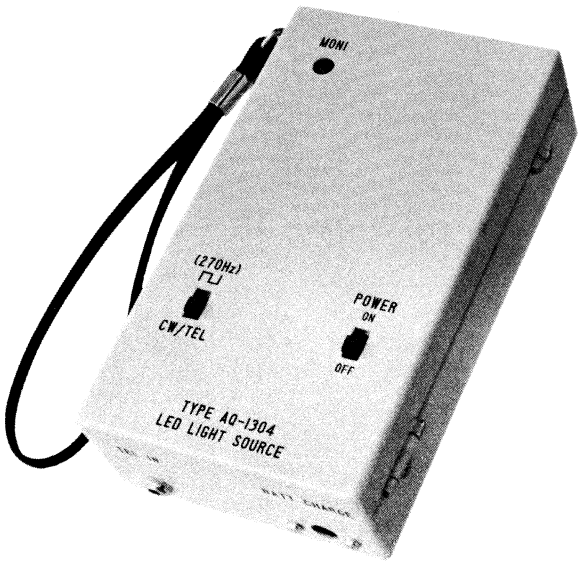
SPECIFICATIONS

Type	AQ-1401	AQ-1411
Use	Base band characteristics measurement of optical devices	
Optical input wavelength	Approx. 850nm	
Optical input level	Approx. −20dBm or less	Approx. −10dBm or less
Base band	1 to 1000MHz	1 to 1000MHz
Base band deviation	Approx. 6dB (with AQ-1311 combined)	Approx. 6dB (with AQ-1311 combined)
Base band output impedance	75Ω unbalanced	50Ω unbalanced
Output connector	SP	BNC
Input connector	D3	
Power requirements	100V AC, 50/60Hz; approx. 20VA	
Dimensions	Approx. 75(H) x 140(W) x 150(D) mm	
Weight	Approx. 2kg	
Accessories supplied	One fuse	

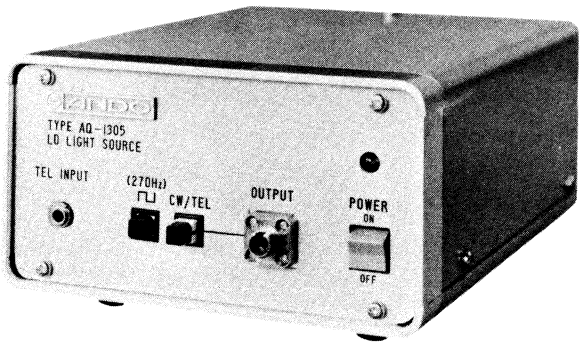
LED, LD LIGHT SOURCES

TYPE AQ-1304 LED LIGHT SOURCE
TYPE AQ-1305 LD LIGHT SOURCE

- *For measurements of optical fiber cable loss and connection loss*
- *For order-wire telephone by use of optical fiber cable*



TYPE AQ-1304
LED LIGHT SOURCE



TYPE AQ-1305
LD LIGHT SOURCE

These light sources are used in the measurement of loss in optical fiber cables. They produce CW or chopped (square wave modulated) light, and permit 270Hz, 50%-duty square wave modulation and also are capable of intensity modulation (IM) with external voice band signal for the order wire telephone.

FEATURES

- Compact and handy (AQ-1304)
- CW or chopped (square wave modulated) light output
- IM capability with external voice band signal
- High output level stability
- AC or DC power supply (built-in rechargeable battery) operation (AQ-1304)

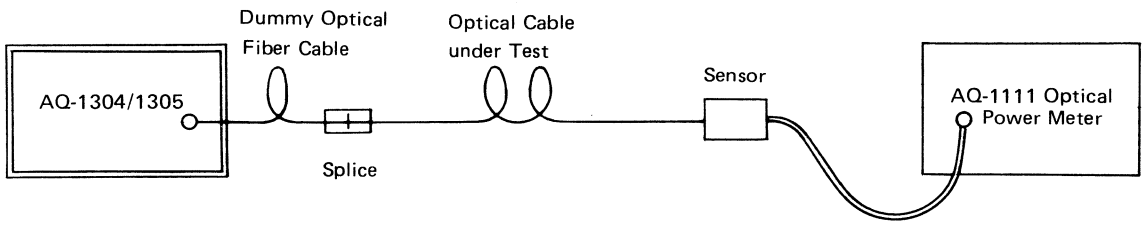
MODELS

For 0.85μm Band:
Type AQ-1304 LED Light Source with AC adapter (rechargeable)
For 1.3μm Band:
Type AQ-1305 LD Light Source

TYPES AQ-1304/1305, LED/LD LIGHT SOURCES

SPECIFICATIONS

Type	AQ-1304	AQ-1305
Use	Measurements of optical power loss and connection loss in optical fiber	
Wavelength	Approx. 0.85μm (LED) (CW or square wave modulation)	Approx. 1.3μm(LD) (CW or square wave modulation)
Output level	Approx. −20dBm or more	Approx. −10 dBm or more
Modulation	IM (intensity modulation) with external voice band signal	
Power requirements	100V AC, 50/60Hz or built-in nickel-cadmium battery (rechargeable by the AC adapter supplied)	100VAC, 50/60Hz
Dimensions	Approx. 37 (H) x 80 (W) x 140 (D) mm	Approx. 75 (H) x 140 (W) x 150 (D) mm
Weight	Approx. 1 kg	Approx. 2 kg
Accessories supplied	One AC adapter	———
Option	Order-wire telephone circuit tester	



Typical Optical Fiber Cable Loss Measurement Configuration

OPTICAL LOSS CHARACTERISTICS MEASURING SETS

TYPES AQ-1011/1012

GP-IB

- *For wavelength characteristics measurements of optical devices*
- *GP-IB control capability*

TYPE AQ-1320 TYPE AQ-1211/TYPE AQ-1210 TYPE AQ-1113

An optical loss characteristics measuring set is used to measure wavelength-optical loss characteristics on optical devices including fiber cables.
The measuring set consists of a light source (a halogen lamp that produces white light), a monochromator, a chopped light power meter and a connector-adapter. Two models of the AQ-1011 and the AQ-1012 are available in accordance with the monochromator employed. Both the monochromator and the power meter have GP-IB remote control capability for automatic measurement system use. Ando's amics 80 desktop computer is recommended as a controller to form a complete automatic measurement system.

CONFIGURATION

Type AQ-1320 Light Source (with a chopper)
Type AQ-1211 or Type AQ-1210 Programmable Monochromator (with a sensor)*
Type AQ-1113 Chopped Light Power Meter
Connector-Adapter

* The AQ-1011 measuring set employs the AQ-1211, while the AQ-1012 uses the AQ-1210.

FEATURES

- Precision wavelength-optical loss characteristics measurements.
- Terminated fiber cables and pig-tail fiber cables can be measured.
- Far-end measurement can be made.

TYPES AQ-1011/1012, OPTICAL LOSS CHARACTERISTICS MEASURING SETS

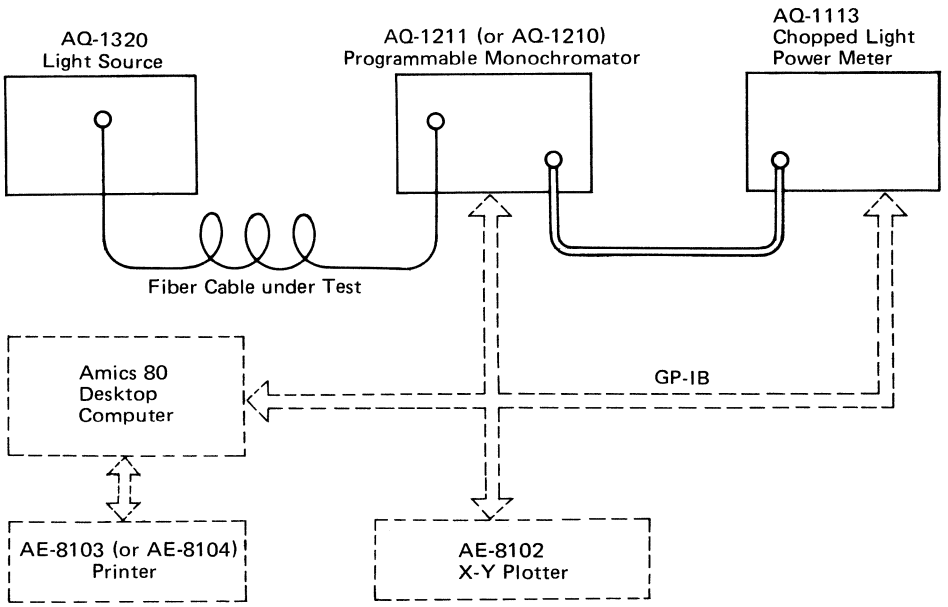
SPECIFICATIONS

Wavelength range: Type AQ-1011 (with the AQ-1211 monochromator):
0.6 to 1.0μm (Si sensor),
1.0 to 1.5μm (Ge sensor).
Type AQ-1012 (with the AQ-1210 monochromator):
1.0 to 1.8μm (Ge sensor)

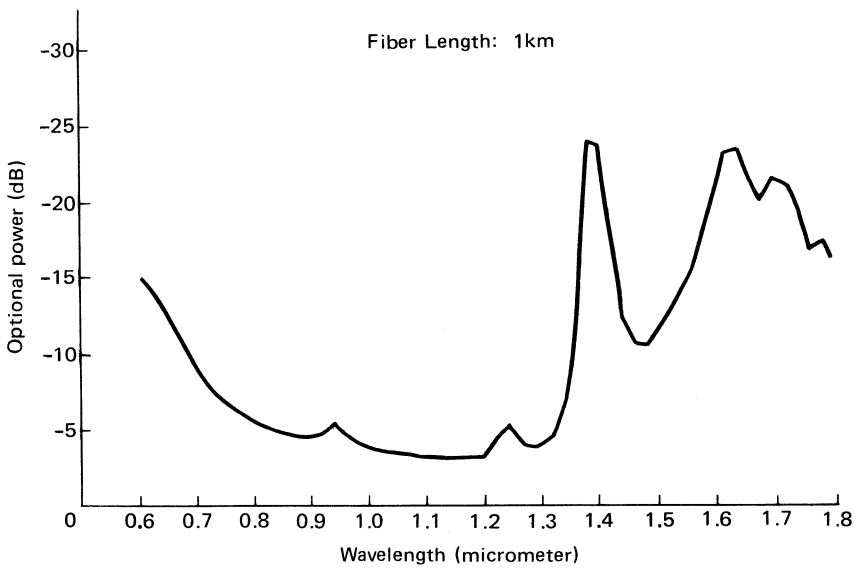
Wavelength resolution: Adjustable from 1 to 20nm.

Measurement accuracy: ±0.5dB

Dynamic measuring range: 20dB or more (with 50/125μm GI fiber).



An Example of Automatic Measurement System Configuration



An Example of Measured Data

LOGIC ANALYZER

TYPE AE-4201

Logic Analyzer

It is extremely difficult to observed and analyze the operation of the entire microprocessor-based digital circuitry with conventional oscilloscopes.

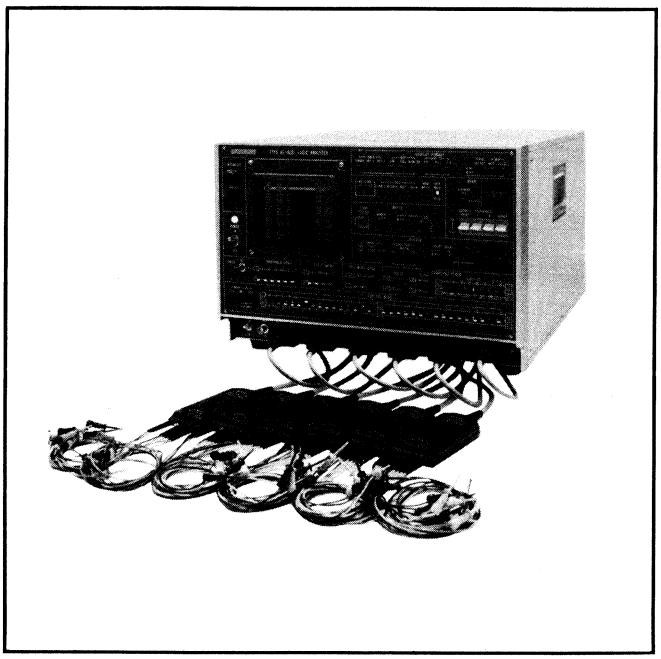
A logic analyzer was developed to provide a means of observing the digital circuit operation in equipment having bus signals like microprocessors. When it is connected to a bus signal, it permits easy observation of the progress of program execution in the microprocessor. The logic analyzer is a measuring instrument that is indispensable to achieving a high degree of efficiency in debugging equipment incorporating a microprocessor.

The logic analyzer is roughly divisible into a timing and a state analyzer.

The timing analyzer displays the multi-channel input signals stored in the memory on the CRT in the form of waveforms, such as time charts, and is suitable for analyzing operations for as a number of instruction cycles. It is often used in checking hardware.

By contrast, the state analyzer displays the multi-channel input signals stored in the memory on the CRT in the form of binary (0, 1) or hexadecimal (0 to F) alphanumerics. It is capable of detailed logic analysis when the microprocessor bus signals are definite. Accordingly, it is quite useful when not only the hardware but also the programs are to be evaluated and tested, as in system debugging.

The AE-4201 Logic Analyzer belongs to the latter analyzer and offers various features, including large memory capacity.



AE-4201 Logic Analyzer

To make best use of a microprocessor, system debugging is of vital importance; in system debugging, programs are executed in the microprocessor-based system, and comprehensive operation tests of the system with hardware, including peripherals, are performed.

Apparatus incorporating a microprocessor has bus signals, such as address bus, data bus, and control bus, and these bus signals vary in a complicated way as the program is executed. In system debugging, it is necessary to monitor bus signals in real-time. Further, it is also necessary to trigger individual operations in the program by particular instructions and observe the sequence of operations that lead to the operations in order to obtain an accurate understanding of each operation.

The AE-4201 Logic Analyzer is a highly flexible instrument that adapts itself to a wide range of test conditions and offers many outstanding advantages.

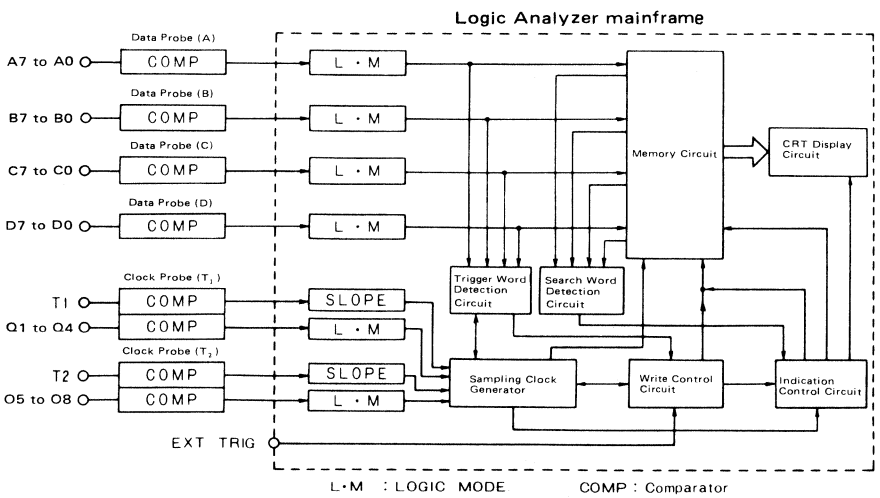


Fig. 1 Block Diagram of AE-4201

TYPE AE-4201, LOGIC ANALYZER

Operation of AE-4201

The block diagram of the AE-4201 Logic Analyzer is shown Fig. 1.

Data entered as input signals are digitalized by the comparator in the data probe, and logic definition is made in the analyzer. The digitalized input signals are then sent on to the memory circuit and trigger word detection circuit. The latter circuit compares the input signal against the trigger word on the basis of the sampling clock pulses derived from the clock and qualifier. When the input signal coincides with the trigger word, the trigger word detection signal goes to the write control circuit so as to control the operation of writing into the memory according to the trigger mode.

The data stored in the memory are sent to the CRT display circuit by the read control signal and displayed according to the specified format. The data stored in the memory are also sent to the search word detection circuit at the same time to be compared against the search word. If they coincide with each other, the search word detection signal goes to the display control circuit. The display control circuit causes the data in agreement with the search word to be displayed in reversed characters or performs control functions, such as automatic retrieval and indication of data on the first line of the CRT.

Features of AE-4201

■ 32-channel Data Inputs

Input signals of up to 32 channels, such as the address bus, data bus, and other peripheral signals, can be connected to the AE-4201 logic analyzer, and word trigger detection, memory, and analysis can be performed simultaneously.

■ Memory Capacity of 1024 Bits per Channel

Each of 32 channels has a memory capacity of 1024 bits. This large memory capacity combined with the unique display capability permits easy analysis of a prolonged program flow. As a considerable amount of detailed information on state can be stored by a single operation, this logic analyzer lends itself to analysis of abnormal operations that may only realy occur.

■ Two Separated Clock Inputs and Qualifier Inputs

This logic analyzer has 2 separated clock inputs and 8 qualifier inputs so that various combinations of 2 clocks and 8 qualifiers are possible when storing data in memory. Qualifier inputs are used to select the necessary clock for desired sampling timing and to provide for the store of significant data only.

■ Control Words

The control word switches are used to select the trigger word, search word, and so forth. Thirty-two control word switches, which correspond to the 32 channels, are provided in this logic analyzer.

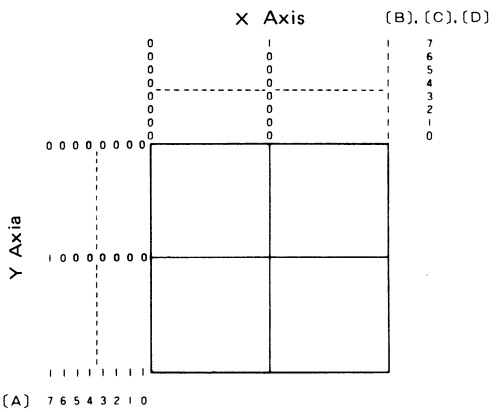
■ Trigger Function

(1) 32 Bits Trigger Word

A trigger word of up to 32 bits can be set by the control word switches corresponding to each of the 32 data input channels.

(2) TRIG START and TRIG STOP Modes

Two modes are provided for starting and stopping memory writing by triggers. When the TRIG START mode is selected, data of up to 1024 samples after triggering are stored; when the TRIG STOP mode is selected, the writing operation is stopped while the memory contents are updated, thus allowing data of up to 1024 samples to be stored before



Map Design

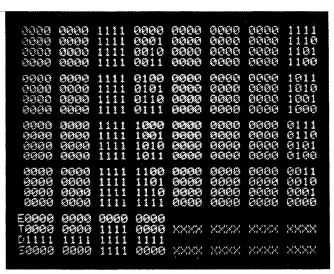


Photo 1 Binary Notation (BINARY)

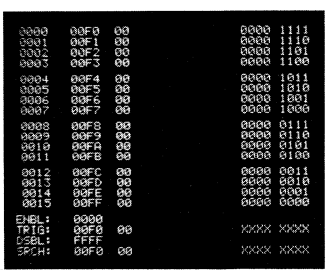


Photo 2 Hexadecimal Notation (HEX 1)

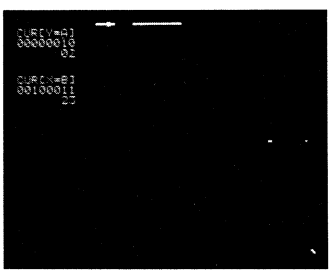


Photo 3 Map

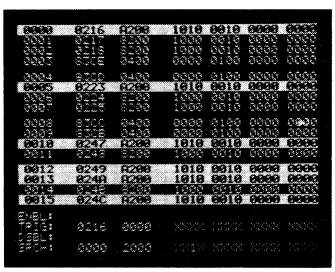


Photo 4 Reversed Characters (Hexadecimal Notation HEX2)

TYPE AE-4201, LOGIC ANALYZER

triggering. These functions permit observation of the states that existed both before and after triggering.
Further, this logic analyzer also has a delayed trigger function. This function permits observation of the states before and after trigger detection by moving the triggering points as well as the state beyond that.

■ **Data Trace Function**

This logic analyzer is capable of data trace function; storing only the data that coincides with the trigger word in memory. This function is of value in knowing the contents that the microprocessor has access to at a particular address or at a particular I/O port.

■ **Unique Display Functions**

The AE-4201 Logic Analyzer performs unique display functions by making use of its large multi-channel memory capacity to advantage.

(1) Table Display Mode

The table display indicates the stored data in binary or hexadecimal notation so as to permit easy understanding of the signal flow and easy comparison of signals with the program list. 16 words of data stored in the memory can be displayed as a table.
This table display has three modes; BINARY, HEX 1 and HEX 2. In BINARY mode, all data of the 32 channels are indicated in binary (Photo 1). In HEX 1 mode, the data of blocks A to C are indicated in hexadecimal and the data of block D in binary. This mode is convenient when observing the program flow or analyzing the operation of the peripheral circuits. In HEX 2 mode, all data of blocks A to D are indicated hexadecimally notation and, at the same time, the data of blocks C to D are indicated in binary. This mode is convenient when analyzing the address information on the basis of status signals (Photo 4).

(2) Map Display Mode

Data are converted into coordinates to be displayed as dots on the CRT (Photo 3). The Y-axis position is determined by the 8 bits of block A, and the X-axis position, by the 8 bits of block B, C, or D.
In the map display mode, it is possible to know the address distribution of the system under test (SUT) and the outline of the program operation by assigning the upper 8 bits to the Y axis and the lower 8 bits to the X axis.
The AE-4201 also features an enlarged display capability of up to 4 magnifications to facilitate map analysis.

■ **Search Function**

In the mode of table display, the stored data in coincidence with the search word are automatically retrieved and indicated on the first line of the table. This function makes it possible to easily retrieve the necessary data from the memory of up to 1024 samples.
Further, the data so retrieved can be indicated in reversed characters for purposes of distinction from other data (Photo 4).

SPECIFICATIONS

Input conditions:	
Number of channels:	Data inputs: 32 channels; devided into four data blocks, A(A7–A0), B(B7–B0), C(C7–C0), D(D7–D0). Clock inputs: 2 channels (T1, T2). Clock qualifier inputs: 4 channels for T1, 4 channels for T2.
Threshold level:	TTL or VAR (–7.5 to +7.5V)
Input voltage:	±15V.
Input resistance:	40kΩ or more (DC).
Logic mode:	"High" equals logic 1 or "Low" equals logic 1 for each data block and clock qualifier.
Clock slope:	+ or – slope.
Max. clock frequency:	5MHz; minimum repetition rate, 200ns.
Trigger:	
Trigger source:	Up to 32 bits word trigger or external trigger.
Trigger mode:	TRIG START, TRIG STOP, or TRACE
Delayed trigger:	Up to 9999 counts by clock, in TRIG START or TRIG STOP mode
Memory capacity:	1024 bits per channel
Table display:	
Display mode:	BINARY, HEX 1, or HEX 2
Search operation:	Possible
Map display:	
Display mode:	16W (16-word), FULL (up to 1024 words) or MONITOR
Data arrangement:	X axis data: data block B, C, or D Y axis data: data block A
Power requirements:	100V AC, 50/60Hz; approx. 170VA.
Dimensions:	Approx. 280H x 425W x 500D mm.
Weight:	Approx. 29kg.

16 MICROPROCESSOR SYSTEM ANALYZERS

AE-4100 SERIES MICROPROCESSOR SYSTEM ANALYZERS

- *Best suited for development, product inspection, and maintenance of hardware and software of various microprocessor applied units.*
- *When the AE-4100 series is connected to a microprocessor applied unit:*
  its unique bus line switching system permits displaying abundant debug functions without any particular consideration taken for hardware and software of the tested unit;
  it serves as the operation panel of the microprocessor to read and write into and from all registers, memories, and I/O ports inside the processor and also to freely control the processor travel.

AE-4101/4103/4105/4106

AE-4101C/4103C/4105C/4106C

Microprocessor System Analyzer

Microprocessors are used in various types of apparatus and systems in all branches of science and industry. Efficient debugging and troubleshooting in research and development, manufacturing inspection, and maintenance of these types of apparatus and systems are of vital importance. The major difference between the systems incorporating microprocessors and conventional systems is whether the main logic functions are performed by wired logic or by program. The former systems, therefore, require testers whose hardware and software differ from those of the conventional ones.

One such new tester is the logic analyzer. The logic analyzer as described in the preceding pages (page 184), furnishes detailed hardware-oriented information.

By contrast, the microprocessor system analyzer furnishes comprehensive information on the whole system viewed from the inside of the microprocessor. The microprocessor system analyzer is connected to the system under test (SUT) and the SUT is operated in various ways by the panel function keys. The results of the SUT operation are digitally indicated for the purpose of evaluating the state of the SUT. The operation is simple, yet efficient tests can be performed.

Ando's microprocessor system analyzers should be selected according to the kinds of microprocessor chips used in the SUTs.

AE-4100 SERIES, MICROPROCESSOR SYSTEM ANALYZERS

FUNCTIONS

- **Simple Connection**

  The basic connection of the microprocessor system analyzer to the SUT can be accomplished by connecting the IC pin plug to the microprocessor IC socket of the SUT.

- **Operated by SUT "CLOCK", "RESET"**

  This microprocessor system analyzer is operated by the SUT "CLOCK" and "RESET", so that it can be operated at the moment the hardware debugging is started.

- **Memory, I/O, and Register Read/write Capabilities**

  Capabilities of read/write between the panel and the SUT RAM/ROM are provided. (The analyzer can read from the SUT ROM but cannot write into it.) It can also check the contents written into the SUT RAM. Further, it can read in from and write out to the SUT I/O port. The analyzer is also capable of reading from and writing to all the registers that can be accessed by the micro-CPU software.

- **Check of SUT**

The analyzer can check the contents of the SUT ROM/RAM, cassette tape, and paper tape with the aid of the built-in cassette MT or an I/O interface (option).

- **Can Execute the Instruction at Any Address**

  The program can be executed at any desired address written in the program counter.

- **Can stop at any address**

  The analyzer can stop the execution of the program at any designated address. Further, the analyzer can resume the execution of the program after read/write of memory or register has been interrupted.

- **Check on the Routes at Fault**

  The analyzer can also check the program, such as an error handling routine, which is not executed unless trouble occurs. This check is done by enabling the address stop function or the memory and register read/write functions.

- **Program Execution Control**

  Program execution is controlled in two modes: RUN and STEP. The program is started from the address set on the program counter. In the STEP mode, the program stops after execution of one instruction. In the RUN mode, the program starts from the address set on the program counter, executing instructions in real-time in succession. Program execution is stopped manually by the STOP switch or automatically by the address stop function.

- **Trigger Output**

  The analyzer generates an external measuring instrument starting trigger signal when the memory is accessed at the designated address. This function can be utilized in various applications, such as waveform observation with the oscilloscope, bus signal latching by the logic state analyzer, analysis of bus and other complicated signals by the logic timing analyzer, and measurement of the program execution time by the universal counter.

- **Program Loading**

  Small programs like the hardware test programs can be loaded through the keyboard. Object programs containing considerable information can be loaded from the built-in cassette MT or from the PTR or TTY paper tape reader through the use of the I/O interface (option). It is possible to collate the program transferred to the analyzer memory with the contents of the cassette MT or paper tape. By the use of the I/O interface card (option), information can be transferred from the paper tape to the cassette MT, so that a cassette MT file can be compiled from the paper tape that contains information output from a cross-system.

- **Memory Dumping**

  When debugging, both memory dumping and the restoration of the programs that existed before the turn-off of power are problems. Ando's microprocessor system analyzers are designed so that through use of the I/O interface card (option) the memory contents can be output in list form or dumped on an object tape. In the analyzer with the built-in cassette MT, its memory contents can be filed on the cassette MT in object form.

- **User Mode RAM**

  When the user mode RAM (option) is added to the analyzer, one RAM providing 8k byte storage can be set at any location of the SUT memory address space of 64k bytes. In system research and development, this RAM can be used as the ROM, and, in mass system production, it can be used to store the test program or to store the revised portion of the program stored in the ROM. In system maintenance, the maintenance program can be stored in this RAM. This user mode RAM finds use in many more applications.

- **Repeat Function**

  The function designated by key is automatically repeated at preset time intervals. The time intervals range from about 1 ms to 65 s and are variable in 1 ms steps. The repeat function permits the following operations.

  - Memory Reset
    The repeat function is added to "WRITE + 1."
  - Memory Check
    By adding the repeat function to "READ + 1", the memory contents are read and indicated once at a preset time.

AE-4100 SERIES, MICROPROCESSOR SYSTEM ANALYZERS

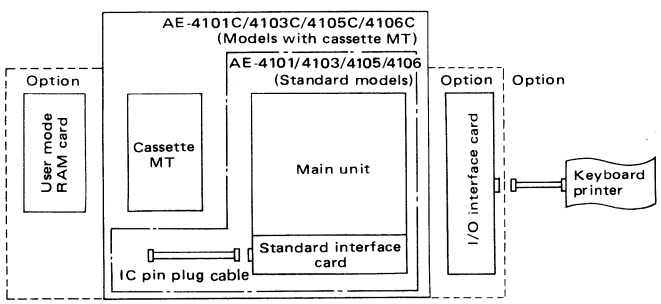
- Execution of Each Instruction
  By adding the repeat function to "STEP" the instruction is executed at a preset time, and the PC, ACC, and flag contents are indicated.
- Waveform Observation with the Oscilloscope
  By adding the repeat function to "READ or WRITE", the waveform is repeated so that the memory or I/O READ/WRITE waveform can be easily observed with the oscilloscope.

■ **Data Write and Read**
Data are input through the hexadecimal keyboard built in the panel of the microprocessor system analyzer. Output data are indicated by an 8-digit display in hexadecimal notation.

■ **Options**
All options that are attached to the microprocessor system analyzers are operated from the 8-digit display and 32-key keyboard built in the panel of the microprocessor system analyzer.

SPECIFICATIONS

Standard models	AE-4101	AE-4103	AE-4105	AE-4106
Models with cassette MT	AE-4101C	AE-4103C	AE-4105C	AE-4106C
Processor to be connected	8080A (INTEL) or equivalent (TMS 8080, AM 9080 μPD 8080, M 58710 HSM 3901, etc.)	Z80-CPU (ZILOG) or equivalent (MK 3880 (MOSTEK) μPD 780, LH 0080, etc.)	8085A (INTEL) or equivalent (μPD 8085A, M 58712, etc.)	8085A (INTEL) or equivalent
Interface pins	Same as in 8080A (INTEL)	Same as in Z80-CPU (ZILOG)	Same as in 8085A (INTEL)	Same as in 8085A (INTEL)
Clock rate	0 to 3MHz			0.5 to 5MHz
Sink current	Clock: high level: 1.5mA or less low level: 100μA or less	Clock: SN 74S00, 1 input Data bus: SN 7400 2 inputs or less	Clock: Oscillating circuit contained in the probe	Clock: high level: 500μA or less low level: 4mA or less RQ/GT: (HOLD) high level: 400μA or less low level: 2mA or less
	Others: TTL SN74LS00, 2 inputs or less			
Display	Address 4 digits, hexadecimal Data 4 digits, hexadecimal			Address 8 digits, hexadecimal Data 8 digits, hexadecimal
Data/address input	By hexadecimal keyboard			
Trigger output	BNC connector, TTL level negative logic. LED lights for approx. 0.5 sec, each time a trigger is output			
Power requirements	100 – 120V, 200 – 240V, AC, 50/60Hz; approx. 70VA			
Dimensions and weight	Approx. 130(H) x 450(W) x 360(D)mm, approx. 7kg			



Note 1. The options marked with * are incorporated in the analyzer proper.
Note 2. The user mode RAM card and IC clip cable do not match all models of microprocessor system analyzer. For details contact Ando.
Note 3. For the interface conditions on PTP, PTR, or keyboard printer contact Ando.

Options

- I/O Interface Card
  The I/O interface card provides for printing the contents of the memory (ROM, RAM) of the equipment under test. If PTR and PTP are provided, the I/O interface card makes it possible to perform other functions, such as memory loading, storage dumping and verification through use of paper tape.
  (The keyboard printer that can be connected to the AE-4100 series has interface restrictions. For details write to ANDO ELECTRIC.)
- User Mode RAM Card
  This 8k byte RAM can be incorporated into this microprocessor system analyzer for use as a memory of the equipment under test. Its memory address is that of the equipment under test.

Models with Cassette MT
The cassette MT incorporated in the apparatus can be used as an I/O interface. It is ideal for field tests and maintenance. If the built-in cassette MT is specified, only either I/O interface card or user mode RAM can be incorporated in this apparatus.

17 IC TEST SYSTEMS

GENERAL INFORMATION

IC devices may be described as produced and available in two general types: DIGITAL and LINEAR.
TEST METHODS for ICs are divided into two types, according to the individual device's function (Fig. 1):
1. DC-PARAMETRIC and FUNCTIONAL
2. AC-PARAMETRIC and FUNCTIONAL

DC-PARAMETRIC TESTS measure the characteristics of an IC-device under **static-DC** conditions. A constant voltage and a constant current power supply are connected to the device under test (DUT) through a relay matrix (Fig. 2). The parameters measured in this type of test include: output voltage, output current, output withstanding voltage, output short-circuit current, input current, and power consumption.

FUNCTIONAL TESTS, performed on relatively sophisticated ICs such as MSI, LSI, and Memory devices, regard the IC as a sort of "black box." Functional characteristics are determined by expressing the input/output data in a truth-table.

Test patterns are generated by the automatic test system (ATE) in accordance with the **truth-table.** The output pulses of the **pattern generator** are applied by a driver circuit to the input terminals of the DUT at a specific input level. The output of the DUT is compared by a **comparator** to the reference level and to the expected output-waveform of the pattern generator. This provides an accurate means for determining and evaluating the performance of the DUT (Fig. 3).

DC-functional tests are performed at relatively slow speeds, while **dynamic-functional tests** are performed at higher speeds and take the **dynamic characteristics** of the DUTs into consideration. **Memory devices** require tests of read/write functions and for mutual interference of individual memory cells within the DUT. Test-patterns, such as "walking," "galloping," and so forth, for this test are generated in various ways. They can be generated in accordance with certain rules and, therefore, are the usually derived from hardware (e.g., memory exerciser).

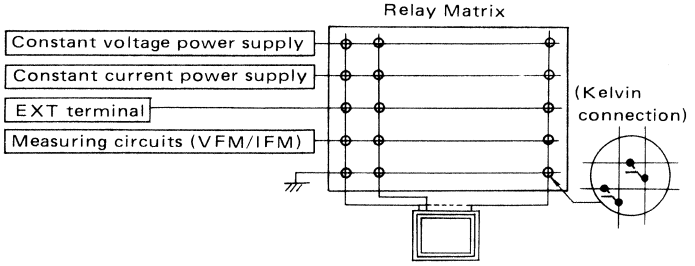


Fig. 2 DC-parametric Test Setup

AC-PARAMETRIC TESTS of digital ICs, commonly referred to as **"dynamic parametric tests,"** serve the important purpose of determining the dynamic characteristics of the DUT. These dynamic characteristics include propagation delay time (t_{pd}), rise time (t_r), fall time (t_f), and so forth. An example of an **AC-parametric test setup** is shown below (Fig. 4).

Dynamic-parametric tests are performed either by the **"sampling method"** or by the **"single shot method."** The **sampling method** requires the repetitive application of pulses of one waveform to the DUT; however, this is difficult to use with LSI devices which require longer test patterns. Therefore, the **sampling method** is used in the measurement of the dynamic characteristics of **SSI** and **MSI** devices. The **single-short method,** on the other hand, permits single-pulse measurements which makes it effective for **LSI.**

AC-parameter tests of linear ICs measure AC or dynamic characteristics such as gain, distortion, and noise. Linear ICs are manufactured in great variety and accurate tests require rather sophisticated peripherals. General practice is to use automatic test systems specifically designed for linear ICs.

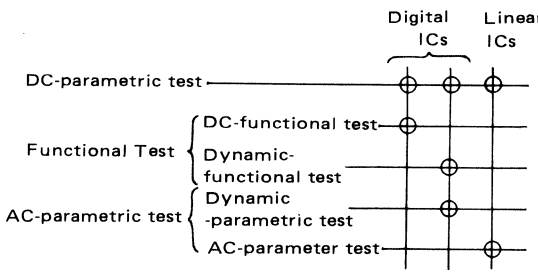


Fig. 1 Test Methods for ICs

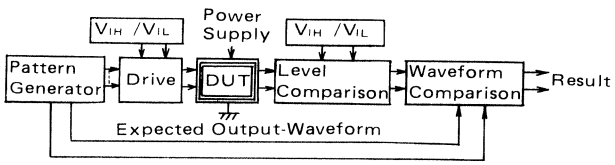


Fig. 3 Functional Test Setup

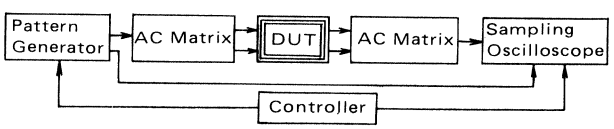


Fig. 4 AC-parametric Test Setup (Dynamic Parametric Test)

DIC-8000 SERIES AUTOMATIC TEST SYSTEMS FOR INTEGRATED CIRCUITS

(I) History of IC Test Systems

The technologies of the design of ICs, materials, and of test methods have been making continuously dramatic progress since the manufacture of IC-devices in commercial quantities became practicable approximately 20 years ago.

In the beginning of the history of IC development, such devices were used primarily in computers where compactness, high speed, high reliability and superior performance – when compared with earlier devices such as vacuum tubes – were most essential. It is popular knowledge that ICs of all types have been finding rapidly increasing applications in virtually all product areas – including consumer, industrial, and military equipment.

Test systems for integrated circuits have evolved from the first generation which used hard-wired logic testers. The second generation employed CPU-based testers. The third generation of automatic test systems, developed in the late 1970's, now includes a host central processing unit (CPU) and a number of **"slave"** stations in a hierarchal/distributed system.

The 1980's offer promises of new levels of sophistication in automatic test systems – which we may begin to refer to as the **"fourth generation."** Typical areas of application for highly sophisticated fourth-generation ATE will include processing units that are truly **central,** receiving, processing, storing, and retrieving data in realtime from a multitude of remotely located automatic test systems. Thus, application software, test and thruput data, maintenance and vital production information will be exchanged and provided as an integral part of a dynamic management information system that is vital to the operation of productive facilities. ANDO has participated in and contributed to the advancement and development of automatic test systems during its several generations of growth.

(II) Requirements of the IC Test System

ANDO is responsible for the development of numerous test systems, in line with the progress of the IC industry. Now, ANDO is the first ATE-manufacturer to develop the fourth generation of test systems incorporating the HIERARCHAL/DISTRIBUTED system-concept. The concept's benefits are briefly described below.

■ Expansion

ICs have been making such rapid and dramatic technological breakthroughs and progress that it is exceptionally difficult to foresee what the future holds in store. This historic set of dynamics presents serious dangers and risks of obsolescence for IC test systems ... unless precautions are taken by the ATE manufacturer to ensure that his product will be able to keep abreast of, or ahead of, the times. It therefore becomes a primary design-imperative to include an expansion capability in a sophisticated ATE. As VLSI progresses, it is inevitable that new test-methods will be mandatory and that existing hardware and software capabilities will have to be expanded.

■ Data/Information Control

History reveals that the IC industry has been geographically centered within the vicinity of large cities. However, in recent years, the IC industry has become a key-supplier to numerous other industries, electronic and non-electronic. As user-demand and IC-manufacturer response increased, plants and production facilities became widely distributed throughout the country and abroad. As plants and production facilities have become geographically dispersed and decentralized, communications have become more complex and difficult; realtime communications often have become impracticable and information that is vital to the effective control of overall operations and decision-making is often outdated by the time it reaches management. It is in this capacity, making available, controlling, and communicating data in **realtime,** that the concept of the **hierarchal/distributed** system makes its true contribution to the growth of the industry and the productivity of the individual IC-manufacturer.

■ Versatility

Conventional R&D-oriented IC test systems are best suited to the collection of data for evaluation. However, because of inherent considerations that are not related to the need for high thruput, such systems are not ideally suited to production-line applications. It is interesting to note, similarly, that many IC test systems which are intended for the production line are not desirable as test systems for R&D purposes.

As ICs are manufactured in a greater variety of types and LSIs are in increased demand, IC test systems must be capable of supporting production-lot quantities of the different IC-types. Also, it is vital to an effective facility to be able to provide quality-control feedback to preproduction sections concerning data that is developed on the production line as IC devices go through the test process. Ideally, a modern IC-test system has the accuracy of an R&D-oriented system and the speed of a production-line system.

GENERAL INFORMATION

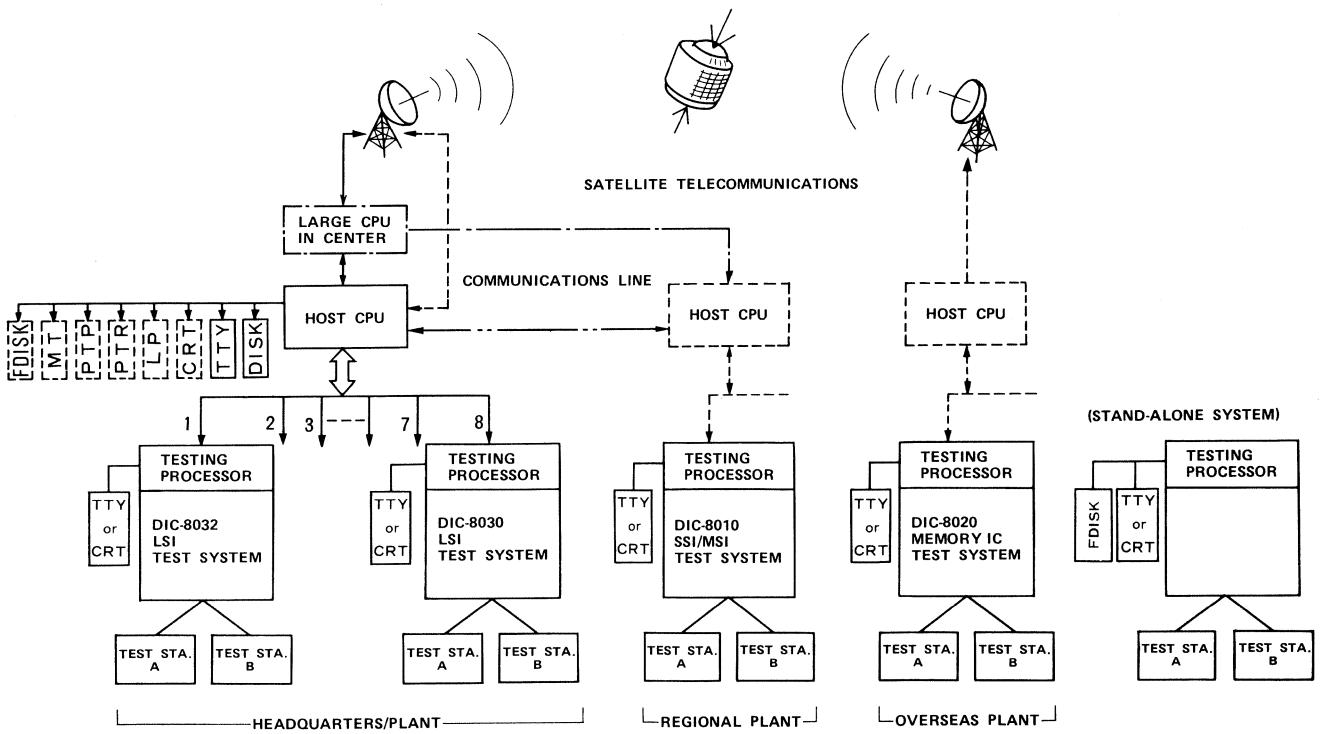


Fig. 6 The DIC-8000 Series Automatic Test System Conceptual Diagram — Hierarchal/Distributed System

The DIC-8000 series of automatic test systems for ICs has been designed with the present requirements and future needs very much in mind. The new concept of the hierarchal/distributed system has been incorporated in the DIC-8000 hardware and software. The DIC-8000 Series — with emphasis on the DIC-8032 system — represents a new generation of IC test systems.

■ High Thruput

IC test systems which are elaborately designed to meet the needs of the times (and of the future times) are unavoidably costly. This tends to contradict the need to reduce the test-cost of ICs to a minimum as IC price-competition increases. To cope successfully with this apparent anomaly, it is essential for a production-line ATE system to have a high thruput capacity.

High thruput is achieved through the use of several up-to-date techniques, including software especially written for high-speed control, high-speed DC-parameter measuring circuitry, multi-channel design, and the simultaneous testing of plural ICs.

■ Optimum Up-Time

To achieve a high operating rate, the reliability of the ATE (MTBF), must be increased and the mean time to repair (MTTR), must be reduced. As the trend toward sophistication and complexity increases, it is quite imperative for the designers of the ATE to carefully consider the selection of components, system burn-in, method of heat dissipation, and other MTBF factors.

To reduce MTTR, the IC test system must have self-diagnostic capabilities that enable the rapid location and identification of malfunctioning elements. The designers of the ATE system must carefully consider the ease of maintainability of the final system.

■ Ease of Operation

A productive IC test system permits rapid changeovers of test procedures from one type of IC to another to assure the elimination of the ATE as a "bottleneck."

The IC tester is generally operated in conjunction with a prober and an auto-handler. Therefore, "ease of operation" necessarily is concerned with the **total** system dedicated to automatic testing.

■ Easy-to-Understand Program Language

A properly functioning IC test system performs three major functions: 1) establishes test conditions, 2) designates test flow, and 3) processes data. Conventional programs intended to activate these functions generally have the disadvantage of being difficult to understand. In order to make the programs easy-to-understand, it is necessary to use a simplified language and a variety of programs written specifically for the individual ATE functions.

(III) DIC-8000 Series — General Information

This section of the General Catalog '81/'82 describes the ANDO DIC-8000 series of IC test systems which has been developed in specific consideration of the **present** and **future** needs of the industry.

BASIC HARDWARE

The basic considerations in the development and design of hardware for the DIC-8000 series include: 1) each system in the series must resist obsolescence and provide expansion capabilities, and 2) the use of the distributed-system concept must permit effective interfacing among the hierarchal organization of the host computer and its test stations.

One of the first problems that ANDO had to solve was the obvious impact on performance/cost. A favorable cost-performance ratio is quite difficult to attain when **expansion capability** to enable testing a great variety of ICs is established as one of the design criteria. In order to satisfactorily solve this problem, the concept of block circuits (modules) was adopted in the design and construction of the ANDO DIC-8000 series. Thus, through the addition of removal of **modules,** the system is rapidly upgraded, expanded or adjusted to meet the user's test requirements and short-term obsolescence may be eliminated.

The second consideration, an operational hierarchy of a multiple number of separate test-stations in conjunction with a single host computer, was resolved and put into production as the ANDO HIERARCHAL/DISTRIBUTED ATE. This arrangement reduces the total operating time of the host CPU per test station, on a time-sharing basis and, as a result, increases the efficiency of the system taken as a whole. The effect on cost/performance is quite positive and beneficial.

The ANDO DIC-8000 series uses a high-speed data-transmission bus capable of sending 16-bits at a rate that is in the order of 100 kW/sec. Wait-time for each test station is thus reduced. Additional design and circuitry considerations achieve the level of high-speed data processing required for VLSI tests.

In order to assure high reliability of the entire system, component-suppliers have been selected on the basis of their statistically proven field-records of quality and high MTBF during many years of work with ANDO. To further assure high reliability, forced convection and induction are employed in the construction of the ANDO systems to provide high-efficiency heat dissipation. Additional precautions against downtime are obtained through the incorporation of a case-temperature detector, a fan-motor revolution detector, and other techniques to enable rapid detection and response to any operational abnormalities.

SUMMIT — A NEW SOFTWARE CONCEPT

"**S**imply **U**nderstandable **M**easuring **M**ethod for **I**C **T**esting" — **SUMMIT** — is a software concept developed by ANDO specifically for automatic IC-testing. In developing SUMMIT, the following operational parameters were carefully considered:

- The software must be interchangeable among IC test systems, despite differences in function and scale, that are dedicated to testing SSI/MSI, memory-IC, and LSI/VLSI.
- The software must provide for data-processing and analysis in R&D applications.
- The software must provide for data-processing and analysis for high-efficiency production-line operations in multi-station applications.
- The software must enable the system to resist obsolescence by providing a capability for system expansion.

As evidence that the parameters have been successfully put into practice, the SUMMIT software developed for the DIC-8000 series now offers several important advantages to the user:

1) The program segment, DATA, that describes the test conditions is separate from the sequence-control segment, MAIN, and is written so as to be rapidly and easily read.

2) The grammar of the SUMMIT language is simplified to enable easy and, therefore, rapid programming.

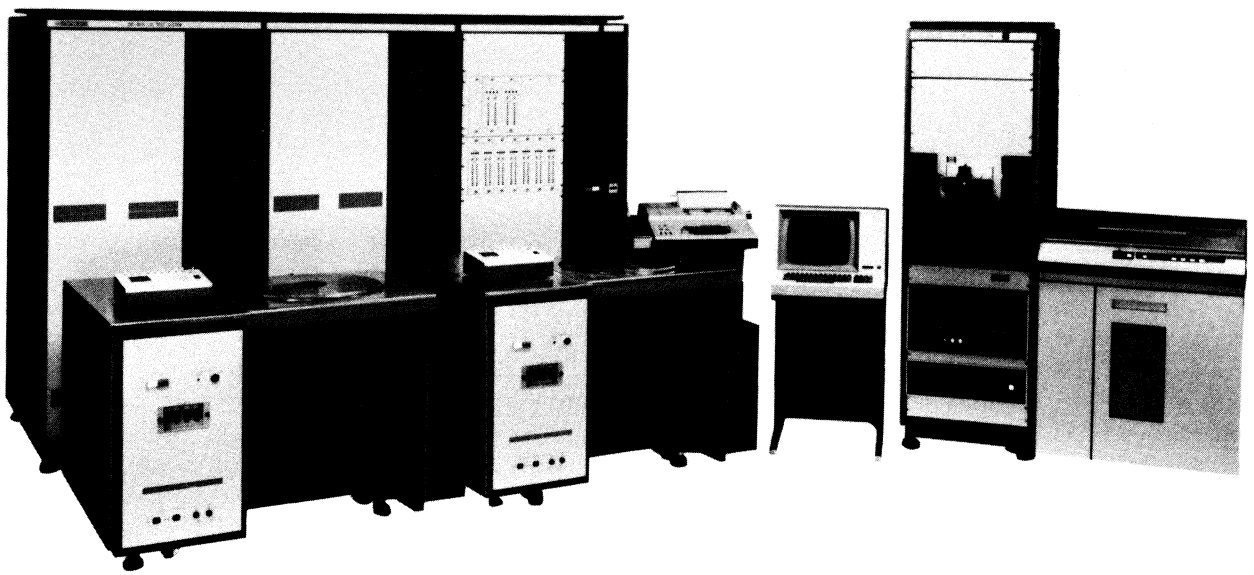
3) The DEFINE segment of the program permits the use of reserved words by any expressions the user prefers.

4) The programs permits modifications, additions, and expansions to be made quite easily as the needs become evident.

AUTO-HANDLERS

Various types of automatic IC-handlers are available from ANDO for use with the DIC-8000 series to assure high speed, high reliability, highly-productive operation of the automatic test system in production-line and incoming inspection applications.

LSI TEST SYSTEM
TYPE DIC-8030



A "family" of test systems, the DIC-8030 is intended for use in testing various types of random-logic LSIs, such as are used in microprocessors, watches, desktop calculators, electronic game machines, cameras, communications equipment, and automobiles. The DIC-8030 is a new generation of LSI test-systems that also considers the possibility of expansion into VLSI. The DIC-8030 tests LSIs to 128 pins, with 65k patterns, at 5/10/20 MHz.

FEATURES

- Random logic LSI devices of up to 128 pins can be tested and measured.
- Pattern rate – 20 MHz max.
- Production of complex timing signals.
  Timing resolution – 200ps
  Timing split – 16 levels
  Burst clock possible
  Externally synchronizable
- Pattern generating functions enable the testing of complex LSI devices such as single-chip microprocessors.
  Pattern memory – 65kW max.
  Multi-loop – 16 levels
  Match mode – 6 modes
- Modulation functions generate many waveforms
  Modulation modes – 18 modes
  Modulation clocks – 16 phases max.
- High-speed DC parametric test
  Four sets of measuring circuits are used to permit simultaneous measurement at several pins.
- High-reliability
  This system, as a production line test system, is provided with many effective functions such as AUTO-PM (self-diagnosis), alarms for bad runs and bad yield rates, and detection of abnormalities in the system.
- Test programming language – SUMMIT – enables programming based on a new concept – easily understandable, flexible enough for future developments.

TYPE DIC-8030, LSI TEST SYSTEM

SPECIFICATIONS

Host System:

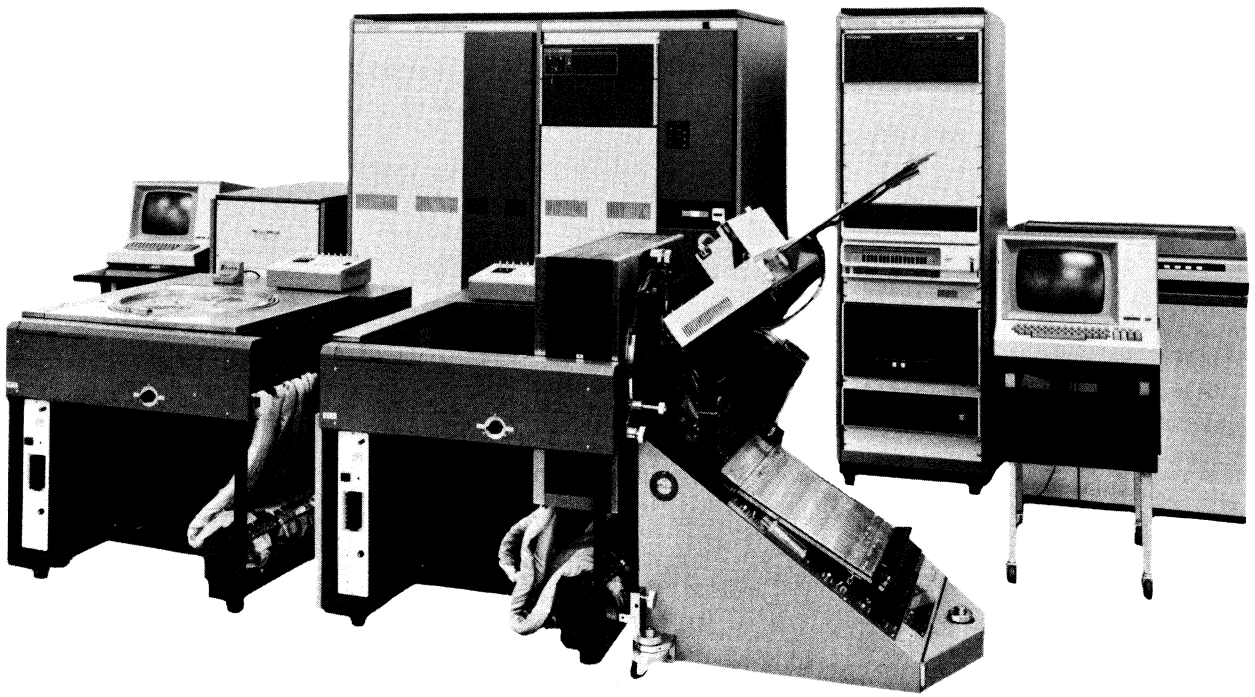
1. Host processor: 64kW/16 bits
2. Peripherals: DISK/CRT/LP/ FLOPPY DISK/PTR*/PTP*/ MT*

Test System:

1. Testing processor: 32kW/16 bits
2. Peripherals: CRT/FLOPPY DISK*/ SP*
3. Test items: Functional test
   DC parametric test
4. Test station: 128 pins max, 2 stations
5. Pin electronics:
   - Driver:
     Output voltage: -2 to +10V
     Amplitude: 12Vp-p max.
     Slew rate: 3ns/1V, 6ns/5V
     I/O switching: Real time
   - Comparator:
     Input voltage: -2 to +10V
     Input impedance: 100nA, 50pF
6. Device power supplies: 4 units max.
   Output: ±30V/500mA.
   Current measurement: Possible
7. Reference voltage supplies: For V_{IH}/V_{IL}, 4 pairs max.
   For V_{OH}/V_{OL}, 2 pairs max.
8. DC parametric test units: 4 units max.
   Measuring range: ±100V, ±400mA
   Measuring resolution: 1mV, 100pA
   Control mode: Multi-control system of 4 units max.
9. Timing generator:
   Clock: 16 phases max.
   Strobe: 3 phases max.
   Internal clock rate: 500MHz
   Programming resolution: Period 2ns
   Delay/width 200ps
   Programming period: 100ns to 10ms
   External synchronization: Possible
   Burst clock: Possible (one phase only)
   Split level: 16 levels
10. Pattern generator:
    Pattern rate: 5MHz/10MHz/20MHz (LINK mode)
    Pattern memory: 128ch x 65kW max.
    Mask memory: 128ch x 4kW max.
    I/O memory: 128ch x 256W max.
    Control mode: JUMP/SUBROUTINE/ LOOP/CONTINUOUS/PAUSE
    Loop counts: 2^{16} counts max.
    Multi-loop: 16 levels
    Match mode: 6 modes
11. Waveform modulation (Pins independent of each other):
    - Driver waveform:
      Mode: RZ/NRZ/EX-OR/THRU/ LEVEL/INV/NEG
      Clock: 7 phases max. (Multi-clock possible)
    - Expectant waveform:
      Mode: RZ/NRZ/INV
      Clock: 2 phases max.
12. Fail data memory: 128ch x 128W max.
    Copy mode: Possible
13. Arithmetic logic unit*: Option to generate patterns effective for testing memory IC
    Number of bit: 16 bits
    Main operation mode: R/W SCAN, MARCHING, GALLOPING, ADDRESS MULTI, PAGE MODE
14. Power requirements: 200V AC, 3 phases, 50/60Hz

Notes: 1. *Symbol indicates optional items.
2. The above configuration is the maximum one.

LSI TEST SYSTEM
TYPE DIC-8032



FULL SYSTEM CONFIGULATION

A "family" of test systems, the DIC-8032 is intended for use in testing various types of random-logic LSIs, such as are used in microprocessors, watches, desktop calculators, electronic game machines, cameras, communications equipment, and automobiles. The DIC-8032 tests LSIs to 128 pins, with 65k patterns, at 5/10/20 MHz.

FEATURES

- **Expansion Capability**

An expansion capability is an important consideration for the design of the hardware and software of the DIC-8032 LSI ATE.

- **Pattern rate — 20 MHz max.**
- **Controlling Capability**

The new concept of the distributed system to control production- and incoming-inspection in individual plant locations, test programs, and a large variety of data.

- **Versatile All-purpose System**

An all-purpose system to support production and R&D facilities. The capability for collecting evaluation data concerning the inspection and acceptance of incoming- and manufactured-products.

- **High Performance**

A high performance/cost ratio derived from the combination of high-speed control software, high-speed DC-measurement circuitry, and the multi-channel system.

- **Ease of Operation**

Test circuit boards in the DIC-8032 are quickly replaced to conform to the type of IC to be tested, further reducing downtime. Rapid and easy connections to the auto-handler and prober.

- **Easy-to-Understand Program Language**

The especially easy program to learn and understand because the test conditions are independent of the sequence of operation and are managed through the central control. Exceptionally flexible software, covering a wide range of applications.

TYPE DIC-8032, LSI TEST SYSTEM

SPECIFICATIONS

Host System:

1. Host processor: 64kW/16 bits
2. Peripherals: DISK/CRT/LP/ FLOPPY DISK/PTR*/ PTP*/MT*

Test System:

1. Testing processor: 32kW/16 bits
2. Peripherals: CRT/FLOPPY DISK*/ SP*
3. Test items: Functional test
   DC parametric test
4. Test station: 128 pins max., 2 stations
5. Pin electronics:
   - For high-speed:
     Driver:
     - Output voltage: -2 to +10V
     - Amplitude: 12Vp-p max.
     - Slew rate: 3ns/1V, 6ns/5V
     - I/O switching: Real time

     Comparator:
     - Input voltage: -2 to +10V
     - Input impedance: 100nA, 50pF

   - For high-amplitude:
     Driver:
     - Output voltage: -20 to +20V
     - Amplitude: 30Vp-p max.
     - Slew rate: 5ns/1V, 10ns/5V, 18ns/10V
     - I/O switching: Real time

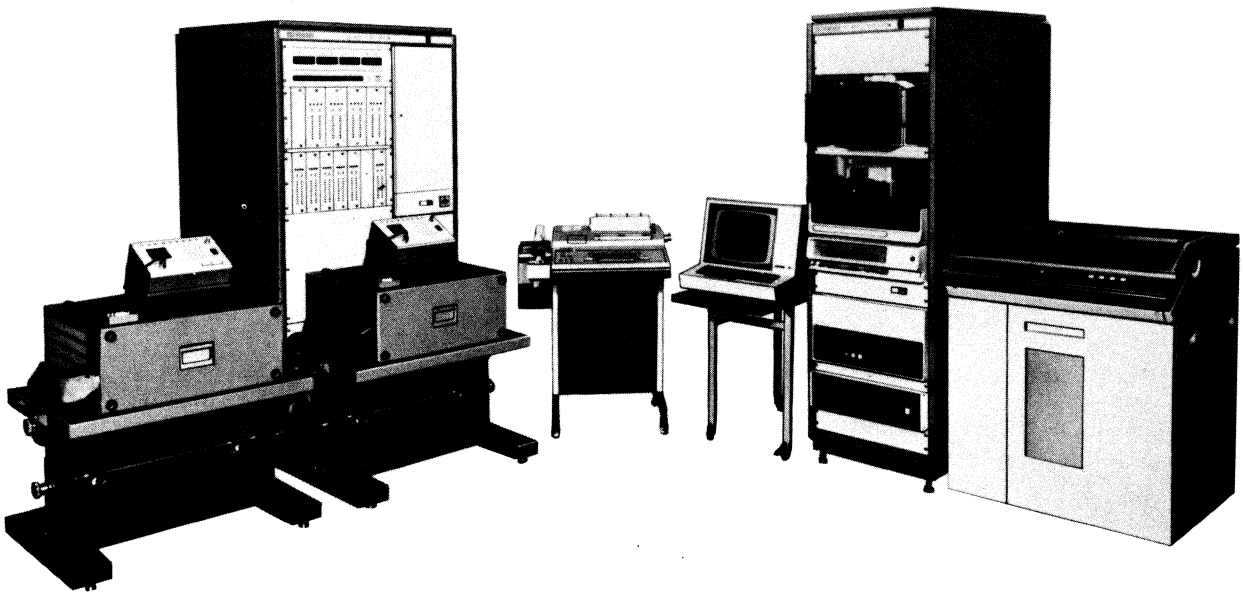
     Comparator:
     - Input voltage: -20 to +20V
     - Input impedance: 10MΩ, 45pF

6. Device power supplies: 4 units max.
   - Output: ±20V/400mA
   - Current measurement : Possible
7. Reference voltage supplies: For V_{IH}/V_{IL}, 4 pairs max.
   For V_{OH}/V_{OL}, 2 pairs max.
8. DC parametric test units: 4 units max.
   - Measuring range: ±40V, ±400mA
   - Measuring resolution: 1mV, 100pA
   - Control mode: Multi-control system of 4 units max.
9. Timing generator:
   - Clock: 7 phases max.
   - Strobe: 2 phases max.
   - Internal clock rate: 100MHz
   - Programming resolution: Period 10ns
     Delay/width 1ns
   - Programming period: 100ns to 10ms
   - Split level: 8 levels
10. Pattern generator:
    - Pattern rate: 5MHz/10MHz/20MHz (LINK mode)
    - Pattern memory: 128ch x 32kW max.
    - Mask memory: 128ch x 1kW max.
    - I/O memory: 128ch x 256W max.
    - Control mode: JUMP/SUBROUTINE/ LOOP/CONTINUOUS/ PAUSE
    - Loop counts: 2^{16} counts max.
    - Multi-loop: 8 levels
    - Match mode: 2 modes
11. Waveform modulation (Pins independent of each other):
    - Driver waveform:
      - Mode: RZ/NRZ/EX-OR/LEVEL/ INV/NINV/NEG/NNEG
      - Clock: 7 phases max. (Multi-clock possible)
    - Expectant waveform:
      - Mode: NRZ/INV/NINV
      - Clock: 2 phases max.
12. Fail data memory: 128ch x 256W max.
    - Copy mode: Possible
13. Arithmetic logic unit*: Option to generate patterns effective for testing memory IC
    - Number of bit: 16 bits
    - Main operational mode: R/W SCAN, MARCHING, GALLOPING, ADDRESS MULTI, PAGE MODE
14. Power requirements: 200V AC, 3 phases, 50/60Hz

Notes: 1. * Symbol indicates optional items.
2. The above configuration is the maximum one.

SSI/MSI TEST SYSTEM

TYPE DIC-8010



The demand-curve for SSI and MSI devices continues to rise quite sharply. At the same time, OEM prices for finished and tested ICs continue to drop. The cost-per-test factor can have a significant effect on the profitability and viability of the IC manufacturer. Increased productivity and thruput at the test station can help reduce costs, consistent with reduced selling prices. The DIC-8010 SSI/MSI Test System responds to these needs. The system tests two parallel rows of TTL MOSs with up to 32 pins.

FEATURES

- High-thruput
  Solid-state switches and high-speed circuits save measurement time.
  High-speed data transfer and control systems save processing time.
  Four sets of measuring circuits permit simultaneous measurement at several pins.
  Multi-measuring function simultaneously measures two devices of less than 16 pins.
- Excellent function test capabilities
  Pattern memory – number of pins x 1kW
  Driver waveform modulation
- Dynamic current measurements by making use of programmable power supplies
- High-reliability
  This system, as a production line test system, is provided with many effective functions such as AUTO-PM (self-diagnosis), alarms for bad runs and bad yield rates, and detection of abnormalities in the system.
- Test programming language –SUMMIT– enables programming based on a new concept – easily understandable, flexible enough for future developments.

TYPE DIC-8010, SSI/MSI TEST SYSTEM

SPECIFICATIONS

Host System:

1. Host processor: 64kW/16 bits
2. Peripherals: DISK/CRT/LP/FLOPPY DISK/PTR*/PTP*/MT*

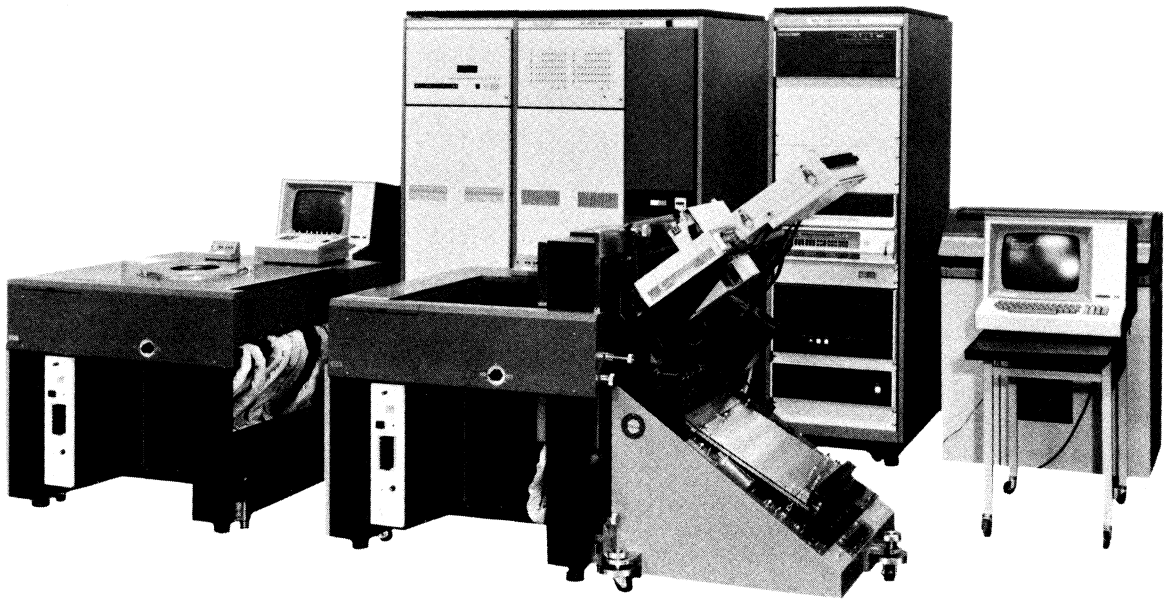
Test System:

1. Testing processor: 32kW/16 bits
2. Peripherals: TTY/CRT*/FLOPPY DISK*/SP*
3. Test items/test time:
   - DC parametric test: 1 ms to 2s
   - Functional test: 2μs to 2s
4. Test station: 32 pins max, 2 stations
5. Pin electronics:
   - Drivers:
     - Output voltage: -20V to +20V
     - Amplitude: 0 to 20Vp-p
     - Output current: 16mA max.
     - Output resistance: 20Ω or less
     - Slew rate: 10ns/V
     - Real time I/O switching: Possible
   - Comparators:
     - Input voltage: -20V to +20V
     - Leakage current: 100nA max.
6. Device power supplies: 4 units max.
   - Output: ±30V/500mA max.
   - Current measurement*: 2μA to 500mA, 7 ranges, 1nA to 1mA resolution
7. Reference voltage supplies: For V_{IH}/V_{IL}, 4 pairs max. For V_{OH}/V_{OL}, 2 pairs max.
8. DC parametric test unit: 4 units max.
   - Voltage range: 0 to ±100V, 3 ranges
   - Current range: 0 to ±500mA, 7 ranges
   - Voltage resolution: 1mV to 100mV
   - Current resolution: 1nA to 1mA
   - Input impedance: 1000MΩ or higher
   - Operating mode: Multi-control system of 4 units max.
9. Timing generator:
   - Clock: 7 phases max.
   - Strobe: 2 phases max.
   - Internal clock rate: 10MHz
   - Programming resolution: Period 100ns, Delay/width 100ns
10. Random pattern generator:
    - Pattern memory: 32CH x 1kW
    - Loop control: Possible, 2^{16} counts max.
11. Driver waveform modulation:
    - Mode: RZ/NRZ/INV
    - Clock: 7 phases max.
12. Fail data memory: 32CH x 16W max.
13. Power requirements: 100V AC, single phase, 50/60Hz or 200V AC, single phase, 50/60Hz

Notes: 1. *Symbol indicates optional items.
2. The above configuration is the maximum one.

MEMORY IC TEST SYSTEM

TYPE DIC-8020



The technological advances in memory-ICs can only be described as "spectacular." With memory capacity of the individual devices increasing in a steep, upward curve, new measuring methods are demanded for IC-testers. The DIC-8020 provides testing capabilities for today's 4k and 16k memory-ICs, and tomorrow's 64k and 256k memory-ICs. Automatic skew-adjustment and realtime complex-pattern generators are an integral part of the DIC-8020 system.

FEATURES

- AX and AY in address pattern can be produced independently of each other and link controls of AX-AY and AY-AX can be performed in real time.
- Address generating function (double address system) which enables the efficient measurement of a large memory has been fully taken into consideration.
- Added functions of real time control and timer interrupt enable the auto-page-mode test.
- Topological scramble function of address.
- Data inversion function in the specified region of DUT.
- Data generating function by means of address function.
- Such complicated patterns as N, N^2, $N^{3/2}$ etc. can be generated in real time.
- Auto-adjust function of timing system.
- Simultaneous testing of 4 DUT's for high thruput.
- Cableless-connections to AHM-625 Auto-handler and prober.
- Test programming language — SUMMIT — enables programming based on a new concept — easily understandable, flexible enough for future developments.

TYPE DIC-8020, MEMORY IC TEST SYSTEM

SPECIFICATIONS

Host System:

1. Host processor: 64kW/16 bits
2. Peripherals: DISK/CRT/LP/ FLOPPY DISK/PTR*/ PTP*/MT*

Test System:

1. Testing processor: 32kW/16 bits
2. Peripherals: CRT/FLOPPY DISK*
3. Test items/test time
   - Functional test: 50ns to 10ms
   - DC parametric test: 1ms to 1s
4. DUT: 2M x 16 bits max.
5. Test station: 2 stations max.
6. Pattern generator:
   - Clock rate: 20MHz max.
   - Micro-instruction memory: 64 bits x 256W
   - Address: Ax8+2*, AY8+2* independence and link generation PAX8*, PAY8* (double address system)
   - Data: 16 bits
   - Subroutine stack: 16 levels
   - Index stack: 16 levels
   - Double command rate: Real time control possible
   - Data generation by address function*: Checker board, X/Y parity, ROW/COL bars, diagonal
   - Arithmetic functions between respective registers*: ADD, SUB, MOV, SHIFT, EX-OR, EX-NOR, OR, AND
   - Test pattern generation: Real time generation of various N, N^2, $N^{3/2}$ patterns
7. Timing generator:
   - Clock: 10 phases max.
   - Strobe: 2 phases max.
   - Program resolution: Period 2ns; Delay/width 125ps
   - Split level: 16 levels
8. Drivers:
   - Output voltage: For MOS -2 to +20V; For Bipolar -2 to +10V
   - Slew rate: For MOS 20ns/20V, 5ns/3V; For Bipolar 3ns/1V, 6ns/5V
9. Comparators:
   - Input voltage: -2 to 10V
   - Accuracy: ±(1% + 10mV)
10. Device power supplies: 4 units max.
    - Output: ±30V/500mA.
    - Current measurement: Possible
11. Reference voltage supplies: For V_{IH}/V_{IL}, 3 pairs; For V_{OH}/V_{OL}, 1 pair
12. DC parametric test unit measuring range: ±100V, ±400mA
13. Various buffer memory: Address topological memory*; Fail data memory*; Data log memory*; Data memory for ROM test*
14. Data processing: Shmoo plot (two-dimensional, three-dimensional), fail map, and other various data processing possible
15. Power requirements: 200V AC, single-phase, 50/60Hz

Notes: 1. *Symbol indicates optional items.
2. The above configuration is the maxmum one.

AUTOMATIC IC TEST SYSTEM

TYPE UIC-5030

- *DC tester featuring superior performance/cost ratio*
- *DC tester replacing Fairchild Series 4000M*

FEATURES

Superior Performance/Cost Ratio

- A microcomputer has been adopted for the UIC-5030 in order to make it compact in size and reduce its cost to a minimum.
- The operating speed of the program power supply and measurement circuit has been increased to such an extent that the processing speed of the UIC-5030 is 1.5 to 2 times as high as that of comparable conventional testers (based on Ando's test data).
- This test system can accommodate up to 4 multiplexed stations so that high efficiency of operation can be attained.

High Reliability

- Advanced technology and know-how which Ando has acquired over years of research and development of IC testers are incorporated into the UIC-5030 to insure high reliability and stability of its performance.

Ease of Operation

- The operator does not need to operate the computer but can easily operate the UIC-5030.
- All commands can be keyed in from the console keyboard using a symbolic language. As the computer is designed to operate in the conversational mode, this system is quite easy to use.
- As this system is designed to indicate relay matrix crosspoints, measurements and limits, program debugging and maintenance are easy.
- CMOS memory is used to store test programs. As it is backed up by a battery and operates as ROM, the programs are stored intact after the power supply is turned off.
- The programmable power supply and measurement circuit can detect not only oscillation and overload but continuous defects. The UIC-5030 is therefore effective in early detection of a system fault,IC defect, and prober and automatic handler faults.

Program Compatibility

- Fairchild Series 4000M test program and fixture can be used without modification.

TYPE UIC-5030, AUTOMATIC IC TEST SYSTEM

SPECIFICATIONS

Test performed:	DC parametric test; 1ms to 990ms (forcing time of voltage/current by programmable power supply).
Devices under test (DUTs):	Bipolar ICs, MOS ICs, digital ICs, linear ICs.
No. of pins of DUTs:	32 pins max.
Main controller:	ADP-800 microcomputer.
Peripherals:	TTY, 50 ch/s. Floppy disk, 2-drive, one-sided single density
Multiplexed stations:	4 stations max. (basic, 1 station).
External boxes:	12 terminals, 3 sets max. (basic, 1 set).
Relay matrix:	10 lines, 32 pins max. (basic, 16 pins), Kelvin connection
Test modes:	Automatic, manual, repeat, data logging.
GO/NO-GO evaluation:	Dual limit, digital comparison method.
Category counters:	Pass category: 5 classifications (5 digits in decimal notation). Fail category: 15 classifications (5 digits in decimal notation).
Voltage measurement (VM) and voltage difference measurement (VMD):	VM: ±2/20/120V, 3 ranges. VMD: ±0.2/2/20/120V, 4 ranges. Resolution, 0.1 (VMD only)/1/10/100mV.
Voltage forcing current measurement (VFM):	
Forcing voltage:	±2/20/120V, 3 ranges.
Current measurement:	±2/20/200μA/2/20/200/500mA, 7 ranges resolution, 1/10/100nA/1/10/100μA/1mA.
Current forcing voltage measurement (IFM):	
Forcing current:	±200μA/2/20/200/500mA, 5 ranges.
Voltage measurement:	±2/20/120V, 3 ranges; resolution, 1/10/100mV.
Digitally programmable power supplies:	5 sets max. (basic, 3 sets). Constant-voltage power supply: 0 to ±120V, 500mA. Constant-voltage/constant-current power supply: 0 to ±120V, 500mA.
Power requirements:	100V AC ±5%, 50/60Hz, approx. 1kVA.
Dimensions:	Approx. 1770(H) x 840(W) x 900(D)mm.

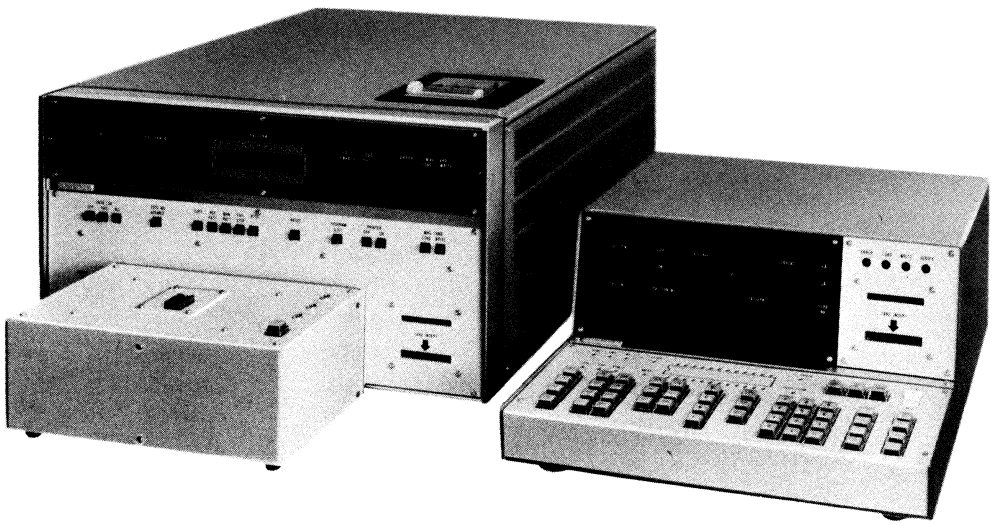
Expansion System

Options	A minimum unit for expansion	Maximum (basic plus options)
Test program area	1 k byte	10 k bytes
Constant-voltage supply (V/F)	1	5 in total
Constant-voltage/constant-current supply (VF/IF)	1	
External box	1	3
Function test unit	1	1
Relay matrix	1 pin	32 pins
Multiplexed station	1	4
Digital voltmeter	1	1
Calibration box	1	1
Relay check box	1	1
External transformer for 200V AC	1	1
Translator (software)	1	1

Pulser unit, large-capacity constant voltage power supply (VF), I/O equipment (LP, CRT, etc.) are available as options.

IC TEST SYSTEM
TYPE DIC-3040

- *Tester for acceptance inspection of digital ICs with up to 24 pins*
- *Functional tests and DC tests*
- *A minute current is also measurable*
- *Pin electronics is adopted, like in a large type tester*
- *Easy generation and modification of test programs*



Microcomputer controlled system

The DIC-3040 is a microcomputer-controlled test system for digital ICs. It permits executing functional tests and DC parameter tests of ICs with up to 24 pins (standard 16 pins) including CMOS, TTL, and DTL.
It features very simple operation. This instrument is ready for testing simply by inputting a programmed magnetic card. Now, measuring results can be obtained by depressing the test switch after inserting a sample into the socket. This instrument is an optimum model as an acceptance inspection tester, because it can be operated easily even by an unskilled operator.

SYSTEM CONFIGURATION

1. Standard configuration

- Tester main body . . . . . 1 unit (no. of sample pins, 16)
  - Built-in units: Printer, magnetic card reader
  - Measuring circuit: Functional test, DC test (voltage, current). A minute current is also measurable.
  - Test head
- Program console . . . . . 1 unit

2. Options

- Pin extension (8 pins)
- Magnetic card reader for program console
- Foot switch for test start
- Printing chart for printer
- Blank magnetic card
- Auto handler

FEATURES

- Programs can easily be generated and modified using program console. With the magnetic card reader (option) combined with this console, programs can be generated at a remote place. Since this program console can easily be operated, even an unskilled operator becomes familiar with this instrument within a short time.
- The tester main body provides various functions and displays for easy debugging of programs, such as COPY function to modify stored pattern information according to acceptable IC.
- Its 80μA current range permits measuring a minute current.
- Function tests can be executed with a load (I_{OH}, I_{OL}) applied to IC output under a condition similar to actual use.
- Its DATA LOG feature provides data logging of all pins to measured as well as failing pins.
- The printer (standard equipment) can print out test results such as failing pin numbers, number of testings, number of faults as well as program lists.
- Programs can be inputted by inserting a programmed magnetic card into the magnetic card reader. Programs can also be inputted directly from the program console.

TYPE DIC-3040, IC TEST SYSTEM

SPECIFICATIONS

TESTER MAIN BODY

No. of sample pins:

Standard 16 pins (24 pins max. including option)

Test performed:

Functional test and DC parameter test

Major operation mode:

AUTO, FAIL STOP, REP PATT, MAN PATT, COPY

Pin electronics:

Pin electronics is independently provided for each pin, so that the driver, receiver, power supply, ground, and other operation modes are obtained according to program specification.

Voltage:

Range	Covering	Accuracy
8V	0 to ±8.19V	±(0.5%+10mV+10mV/50mA)

Current (Source current):

Range	Covering	Accuracy
800mA	0 to + 200mA	±(3% + 1mA)
8mA	0 to + 8.19mA	±(3% + 10μA)
80μA	0 to + 81.9 μA	±(3% + 500nA)

Current (Sink current):

Range	Covering	Accuracy
800mA	0 to −200mA	±(3% + 1mA)
8mA	0 to −8.19mA	±(3% + 10μA)
80 μA	0 to −81.9 μA	±(3% + 500nA)

Power requirements:

100V AC ±10%, 50/60Hz

Dimensions:

Approx. 260(H) x 480(W) x 550(D) mm (excluding test box)

PROGRAM CONSOLE

Functions:

Programming function, editor function, program transfer function, read/write function of magnetic card

Power requirements:

100V AC ±10%, 50/60Hz

Dimensions:

Approx. 165(H) x 370(W) x 425(D)mm

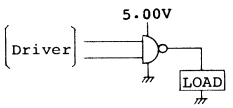
EXAMPLE OF PROGRAM

```
DUT PINS  14 ──────────────── Indicates 14-pin IC

TEST NO.  0 ──────────────── Test 0 = Function test
VFM2      1, 2, 4, 5, 9, 10, 12, 13
  VH      3.00V
  IH      4.00mA
  VL      0.00V
  IL     -8.00mA
IFM       3, 6, 8, 11
  VH      2.40V
  IH     -0.40mA
  VL      0.40V
  IL        16mA
GND       7
  VL      0.00V
  IL     -200mA
PWR       14
  VH      5.00V
  IH      200mA
MEAS PIN  3, 6, 8, 11
PATT      11222
          33266
          55332
          66156

TEST NO.  1 ──────────────── Test  1 = VOH test
VFM2      1, 2, 4, 5, 9, 10, 12, 13
  VH      4.50V
  IH      4.00mA
  VL      0.80V
```

[Test conditions]



Driver	LOAD
V_{IH} = 3.00V	I_{OH} = -0.40mA
V_{IL} = 0.00V	I_{OL} = 16mA

EXAMPLE OF DATA LOG

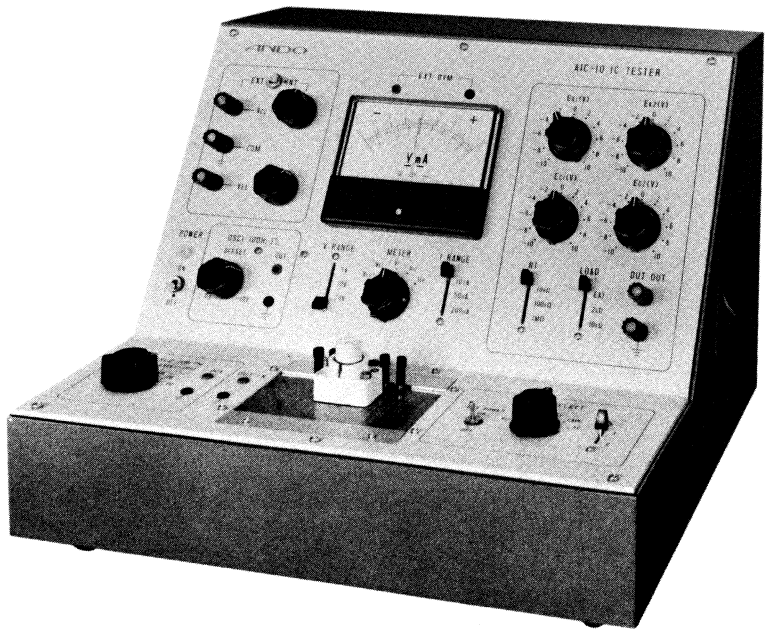
```
TEST NO.  0                    ──→Test 0...  100 tests can be executed
  FAIL PIN                                   from test 0 to test 99.
   NONE                                      Test 0 ... Function test
                                             Test 1 to 99 :DC parameter test
                               }──→No non-conforming pin exists.
TEST NO.  1                    ──→Test 1
  FAIL PIN
   6  8                        }──→Pins 6 and 8 are defective.

  1 VFM2                       ──→Applied level or specified value
     4.50V   4.00MA            ──┐DUT pin No.
     0.80V  -8.00MA            ──┐Pin electronics mode
  2 VFM2                       ──┐VFM2  Driver mode
     4.50V   4.00MA            ──┐VFM1  Voltage applied, current
     0.80V  -8.00MA            ──┐      measuring mode
  3 IFM                        ──┐IFM   Current applied, voltage
     2.81V* -0.40MA            ──┐      measuring mode
     0.40V    16MA              ──┐PWR   Power supply mode
  4 VFM2                       ──┐GND   Ground mode
     4.50V   4.00MA            ──┐NC    Open
     0.80V  -8.00MA            ──┐"1" level voltage
  5 VFM2                       ──┐"1" level current
     4.50V   4.00MA            ──┐6  IFM
     0.80V  -8.00MA            ──┐2.10V*  -0.40MA
  6 IFM                        ──┐0.40V    16MA
     2.10V* -0.40MA            ──┐"0" level voltage
     0.40V    16MA              ──┐"0" level current
  7 GND
     0.00V  - 200 MA           ──┐Asterisked values indicate
  8 IFM                        ──┐measured values.
     1.75V* -0.40MA
     0.40V    16MA
```

IC TESTER

TYPE AIC-10

● *Compact tester for op amps and comparators*



The AIC-10 is a compact tester which makes simple DC and AC parameter tests of operational amplifier and comparator ICs. The tester finds extensive applications not only in production tests and incoming tests but also in tests of various electronic devices involving the use of operational amplifier or comparator ICs.

FEATURES

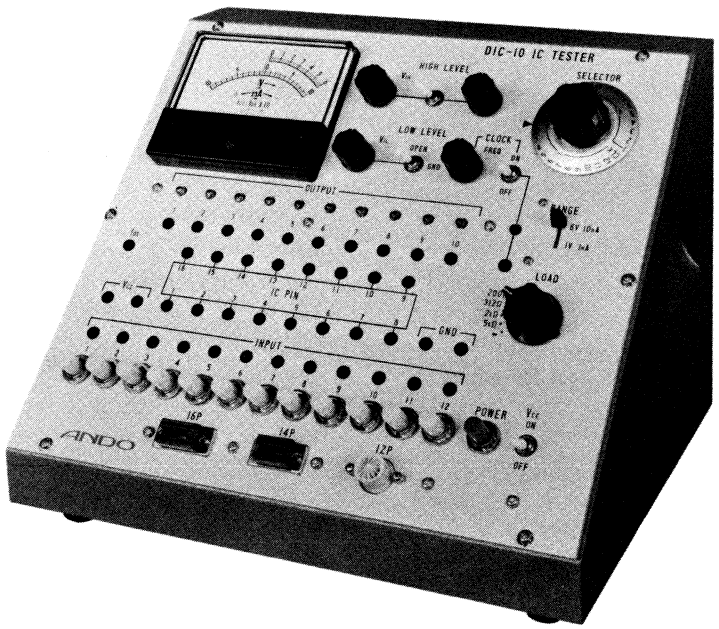
- DC parameter tests are performed by the null amplifier method, which is recommended by EIAJ (Electronic Industries Association of Japan).
- Heated DUTs can be tested by the use of Type THC-12 Thermal Test Heater (option).
- Although the tester is small in size, it contains voltage forcing supplies for DUT, bias supplies, oscillators (square wave oscillator and sine wave oscillator), etc.

SPECIFICATIONS

ICs tested:	Operational amplifiers and comparators.
Tests performed:	
DC parameter tests:	I_{CC}, 0 to 200mA. I_{EE}, 0 to -200mA. V_{IO}, 1 to 20mV. I_{IO}, 2nA to 2μA I_B, 2nA to 2μA. A_V, 60 to 80dB. CMR, 60 to 80dB. (In addition, other DC tests include SVR, R_{ID}, R_O, P_D and VCM).
AC parameter tests:	SR, ts, BW, NL, etc. (The AC tests require internal oscillators and an external oscilloscope).
Setting range	
V_{CC}:	0 to +20V or external power supply.
V_{EE}:	0 to -20V or external power supply.
E_K, E_C:	-10 to +10V in 2V steps.
R_I:	10kΩ, 100kΩ, 1MΩ.
Load:	2kΩ, 10kΩ, ∞ or external load.
Built-in oscillators (for AC tests):	100 Hz square wave oscillator, 1kHz sine wave oscillator.
Power requirements:	100V AC, 50/60Hz; approx. 20VA
Dimensions:	Approx. 250(H) x 350(W) x 300(D) mm.
Weight:	Approx. 8 kg.

IC TESTER
TYPE DIC-10

● *Makes both functional and DC parameter tests*



Though compact in size, the DIC-10 is a full fledged tester capable of performing functional and DC parameter tests on bipolar digital ICs having a maximum of 16 pins. Outputs of ICs can be easily checked on the front panel lamps. Currents and voltages can be read on the front panel meter.

FEATURES

- All digital ICs of bipolar type (gate circuits, flip-flop circuits, shift registers, etc.) can be tested.
- The DIC-10 is human-engineered to the maximum to simplify the programming and operational training.
- The DIC-10 is ideal for both production and laboratory work. It can also serve as a training set for educational use.

SPECIFICATIONS

ICs tested:	Bipolar type digital ICs (DIP ICs with 14 and 16 pins; TO-5 ICs with 12 pins).
Tests performed:	DC parameter and functional tests.
DC parameter tests:	V_{IL}, V_{IH}, I_{IL}, I_{IH}, V_{OL}, V_{OH}, Icc, Ios.
Test results:	Indicating meter and lamps.
Programming items:	Vcc (x2), GND (x2), clock (x1), input current (x12), output voltage (x10).
Setting voltage:	
Vcc:	4.5 to 6V, continuously variable.
V_{IL}:	0 to 1V, continuously variable and GND.
V_{IH}:	1.5 to 5V, continuously variable and Vcc.
Clock:	
Frequency:	0.2 to 2Hz
Duty:	Approx. 1:1.
Level:	Setting value of V_{IL} and V_{IH}.
Output load:	200Ω, 312Ω, 2kΩ, 5kΩ, ∞ (500kΩ or more).
Indicating meter range (full scale):	
Vcc, V_{IL}, V_{IH}, V_{OL}, V_{OH}:	1V, 6V.
I_{IL}, I_{IH}:	1 mA, 10 mA.
Icc, Ios:	10 mA, 100 mA
Accuracy:	Within ±5%.
Power requirements:	100V AC, 50/60Hz; approx. 16VA
Dimensions:	Approx. 215(H) x 300(W) x 225(D) mm.
Weight:	Approx. 5.5 kg.

18 DESKTOP COMPUTER

DESKTOP COMPUTER

***amics 80*, TYPE AE–8101**

Today, it is not at all uncommon to have people who are not computer specialists use computers in various fields. Naturally, they need computers that are easy to use, needing only a minimum of labor. It is in order to meet these needs that Ando's desktop computer amics 80 Type AE-8101 has been developed. It is so designed that anyone can readily and easily derive full computer capabilities from the component units placed side-by-side on the desk.

The trend in various kinds of measurements is also definitely toward the use of computers; the variables measured by measuring instruments are fed to a computer, and the computer in turn automatically determines the conditions of measurements yet to be made. It ultimately decides whether the device or circuit under test is at fault, or analyzes the data to find the cause of faults. When a system is formed through a combination of a computer and measuring instruments, it is called an "ATE System."

What matters about ATE is a common interface for computers and measuring instruments. The leading measuring instrument manufacturers of the world have already adopted the common interface bus (IEEE 488), and it has been incorporated in newer models.

The AE-8101 is a desktop computer that Ando developed to meet the changing needs of the times and is primarily intended for use with ATE systems.

Basic Component Units

The AE-8101 Desktop Computer consists of the computer proper (CPU, memory, GP-IB, CRT display, and mini-floppy disk) and a keyboard unit.

- **CPU**
  The CPU is basically a microprocessor, but it is designed to perform many more supplementary functions. In addition, the DMA capability, multiple interrupt capability, real-time clock, and other capabilities can be added to the CPU so that a high degree of system control efficiency can be achieved.
- **Memory**
  The memory of the AE-8101 consists of an IPL ROM and a program 64kB RAM. The RAM is comprised of 16k bit chips to obtain a memory whose access time is as fast as 250 ns.
- **GP-IB**
  The GP-IB conforms to the IEEE 488 standard and consists of talker, listener, and controller functions. The GP-IB performs the function of either a controller or a device in the system.
- **CRT Display**
  A 9-inch CRT is incorporated in the display. It can indicate up to 640 characters (40 characters x 16 lines), and the characters include alphabets (capital and small letters), Greek letters, numericals, and symbols. The CRT display has a built-in refresh memory in its control section. As it is independent of the system RAM, it reduces the system overhead to zero without occupying the system bus in refreshing the CRT screen.
- **Mini-floppy Disk**
  Two large-capacity duplex type floppy disks are incorporated in the AE-8101 desktop computer. They are independent of each other and can be used either at normal density or double density. The floppy disk is formatted by the soft sector method. In the case of normal density, data are recorded with FM; in the case of double density, MFM is employed in data recording. When two sides of the floppy disk are used in the double density mode, the total memory capacity of each floppy disk is 256k bytes, four-fold the normal density memory capacity of one side of the floppy disk. Each AE-8101 Desktop Computer has the same memory capacity as eight floppy disk units with a one-side mini-floppy disk. The mini-floppy disks used in the AE-8101 Desktop Computer even compare favorably with an 8-inch floppy disk whose one-side memory capacity is no more than 237k bytes.
- **Keyboard Unit**
  The keyboard unit consists of a typewriter-type keyboard based on the key arrangement of the JIS (Japanese Industrial Standard) C6233, a calculator-type keyboard with 10 numeral keys, and 16 function keys. The codes to be entered through the keyboards include alphabets (capital and small letters), Greek letters, numerals, and symbols. The keyboard unit is separate from the desktop computer proper and can be installed apart from the desktop computer proper in any place where it is most easy to use.
- **IPL**
  When the power supply is turned on and the system diskette is set to the mini-floppy disk, the IPL program automatically starts to run. On completion of a simple self-diagnosis, the IPL program loads the disk operating system from the system diskette, setting off the operating system.

  1. Self-diagnosis
     The hardware that is required for the operation of the desktop computer is tested in an extremely brief

time. The main tests consist of simple read/write checks on the RAM and CRT display refresh memory. If abnormalities are detected, the errors are indicated on the display and the program stops.

2. Operating System Loading
   A particular system loader is filed in the system diskette, and the IPL program loads the system loader from the system diskette. The operating system is loaded into the system RAM by the system loader. When the operating system loading is completed, the operating system runs the program.

■ **Operating System**

The operating system is software that controls various types of information required both to operate and to maintain the system. Although its outward appearance is that of a simple black box, its major function consists of controlling system resources and input/output operation. The operating system employed in the AE-8101 Desktop Computer is a real-time one based on the floppy disk and it has an interface with the computer system by means of a program language.

■ **BASIC**

All programs that the user prepares in the AE-8101 Desktop Computer are written in BASIC. BASIC is a higher-order algebraic programming language developed at Dartmouth College. The language used in the AE-8101 is based on functions as stated below.

1. BASIC Statement (Basic Language)
   DATA, DIM, END, FOR ~ TO ~ GOTO, INPUT, IF~GOTO, LET, NEXT, PRINT, REM, SPC, STOP, TAB
2. BASIC Statement (Expanded Language)
   DEF, EXCHANGE, FN, FNEND, FNRETURN, FOR~TO~STEP, GOSUB, IF~THEN~ELSE, KILL, LVAR, MID$, ON~GOSUB, ON~GOTO, PRECISION, PRINTUSING, RETURN, etc.
3. Operators
   +, −, *, /, ∧, AND, OR, NOT, <, >, =, <=, >=, <>
4. Built-in Functions
   ABS, INT, SGN, TIMER, SQR, EXP, SIN, DSIN, COS, DCOS, TAN, DTAN, ATN, DATN, LOG, LN, ASC, CHR$, LEFT$, RIGHT$, LEN, MID$, STR$, etc.
5. Commands
   AUTO, CLEAR, LIST, NEW, RENUMBER, RUN, LOAD, SAVE, EDIT, OPEN, CLOSE, etc.
6. Input/output Relations
   - Particular I/O devices can be designated for the input/output of related statements and commands (INPUT, PRINT, LIST, etc.).

Examples:

PRINT A	Output A to CRT.
PRINT#CSL, A	Output A to CRT.
PRINT#SI0, A	Output A to printer.
PRINT#GP0, "T"; A	Output A to GP-IB.
PRINT#FD0, A	Output A to disk file having FD0 as a logical name.

- The I/O statement permits interface with GP-IB.
  Examples:
  PRINT#GP0, "S□□ ..... □"
  A command is output to GP-IB.
  PRINT#GP0, "T□□ ..... □"
  Data are output to GP-IB.
  INPUT#GP0, "L", □□ ..... □
  Data are received from GP-IB.
  LIST#GP0
  Program list is output to GP-IB.

Examples of Programming

1. Calculation of the Roots of Quadratic Equations by the Root Formula

- Formula: $\frac{-b\pm\sqrt{b^2-4ac}}{2a}$ where, $b^2-4ac \geqq 0$

- Program Example 1:

```
10 INPUT A, B, C
11 D = B*B-4*A*C
12 IF D<0 GOTO 21
13 IF D=0 GOTO 18
14 E = (-B+SQR(D))/(2*A)
15 F = (-B-SQR(D))/(2*A)
16 PRINT E, F
17 STOP
18 E = -B/(2*A)
19 PRINT E
20 STOP
21 PRINT "ERROR"
22 END
```

- Program Example 2 (A set of IF statements are used.):

```
10 INPUT A, B, C
11 D = B∧2-4*A*C
12 IFD<0 THEN PRINT "ERROR" ELSE
   IFD=0 THEN PRINT -B(2*A) ELSE
   PRINT(-B+SQR(D))/(2*A), (-B-SQR(D))/
```

TYPE AE-8101, *amics80* DESKTOP COMPUTER

```
(2*A)
13 END
```

2. Calculating the Area of a Triangle by Heron's Formula
   - Formula: The area of a triangle having sides a, b, and c is calculated by the formula, if d = (a + b + c)/2

     $$S = \sqrt{d(d-a)(d-b)(d-c)}$$

   - Program Example 1:

```
10 INPUT A, B, C
11 D = (A+B+C)/2
12 S = SQR(D*(D–A)*(D–B)*(D–C)
13 PRINT S
14 END
```

   - Program Example 2 (multi-statement is used.):

```
10 INPUT A, B, C: D = (A+B+C)/2: PRINT
   SQR(D*(D–A)*(D–B)*(D–C)) : END
```

3. Outputting Sine Waves to the X-Y Plotter
   This operation is based on the assumption that one cycle of sine wave is divided into 36 points (in 10 degree steps), expressing the amplitude in 10 cm, and that the desktop computer address is "1" and that of the X-Y plotter "3."

```
10 PRINT #GP0, "A!C7 S@AP?PAP#"
```

"A!C7 S@AP?PAP#": Command

Desktop computer initialize

```
20 PRINT #GP0, "UHM0, 1010, D"
```

"UHM0, 1010, D": Setting of pen start point of X-Y plotter

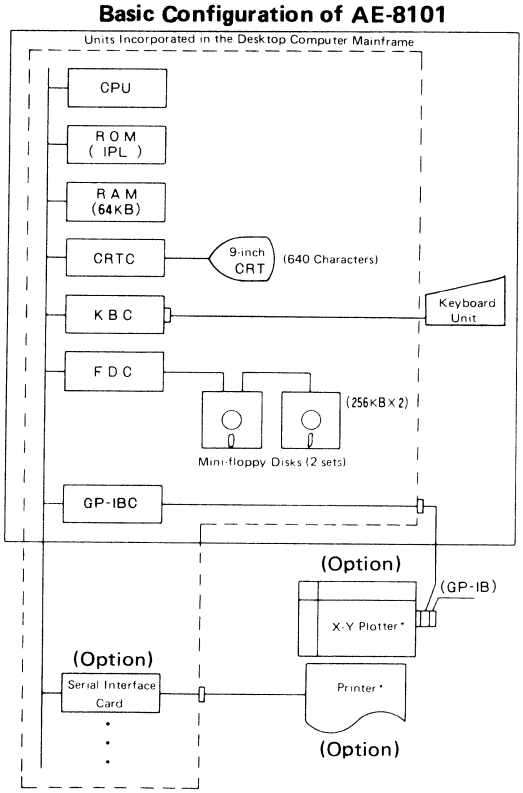
```
30 FOR A = 0 TO 360 STEP 10
40 B = DSIN (A) * 1000 + 1010
50 C = A * 10
```

40, 50: X-Y coordinate calculation

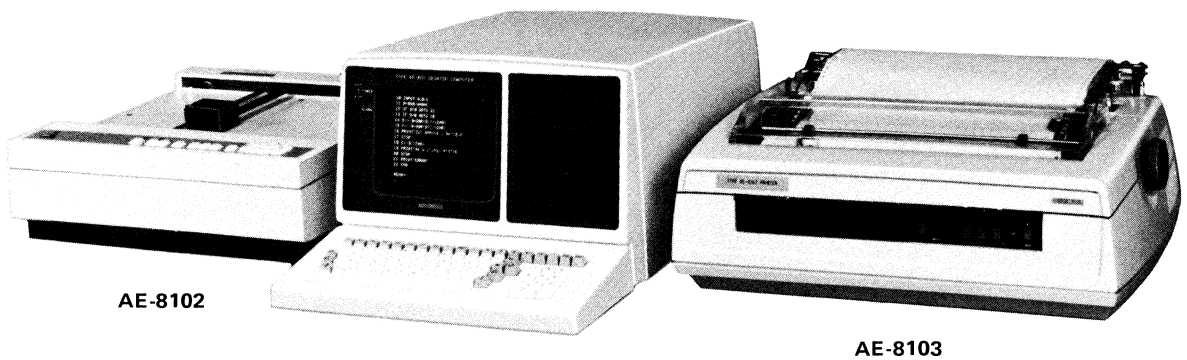
```
60 PRINT #GP0, "U" ; C ; ", " ; B ; ", "
70 NEXT
80 END
```

"U" ; C ; ", " ; B ; ", ": X-Y corodinate output

Basic Configuration of AE-8101



* Indicates the units that are to be provided by the user.



AE-8102

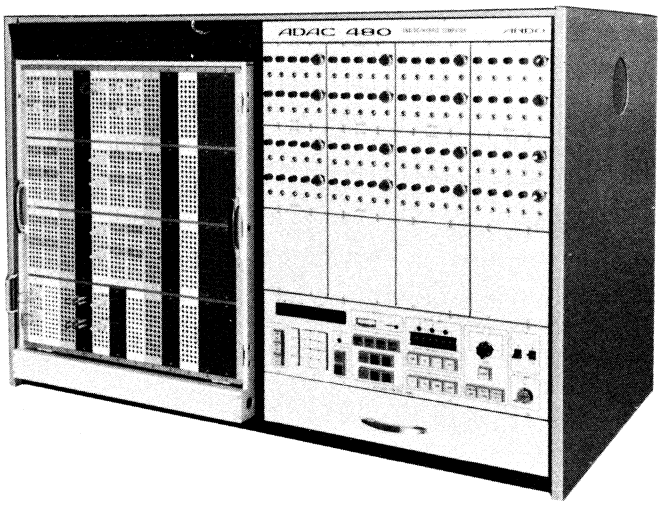
AE-8103

Mainframe

19 ANALOG COMPUTER

ANALOG COMPUTER
ADAC 480

● *High-performance, general-purpose, analog computer*



FEATURES

■ **Guaranteed High Stability and Reproducibility**

- The operational amplifier incorporating ICs with FET choppers and the dual plane bearing pin contact system of the patch board have been adopted in desk-top analog computers of this sort for the first time in Japan. The high stability and reproducibility imparted by these original designs have been received favorably by a large number of users. These two features are now indispensable to the analog computer.

■ **Large Capacity and Superior Performance**

- Each computing element incorporates an operational amplifier, yet features a compact design.
- Number of Main Computing Elements (maximum capacity)

Summer	24
Integrator	24
Multiplier	10
Potentiometer	70
F. DFG	6
Comparator	8
Electronic switch	16

- The smaller the number of computing elements used in the analog computer, the higher is its accuracy. As the ADAC Analog Computers permit programming with a minimum of computing elements, they perform calculations with a high degree of precision.
- As a high-precision analog section and a functional logic section are accommodated in one patch board, these computers permit easy analog hybrid computation.

■ **High-precision Calculations**

- The operational amplifier operates at 8 MHz or more and is controlled by a high-speed electronic switch. It performs high-precision operations over a wide speed range from low to 0.1 msec. Further, the integrator mode and time scale are controlled in unit fashion so that 2- or 3-mode automatic operations and multi-time scale analog hybrid computations can be performed with a high degree of precision.

■ **Expandable to the Hybrid Computation System**

- All operations can be performed by use of TTL level external signals. The ADAC 480 can therefore be expanded to the hybrid computation system. The digital potentiometers and hybrid trunk units that are required to convert the analog computer to a hybrid system are available from Ando.

■ **Great Ease of Use**

- Unitized Computing Elements
  Almost all computing elements incorporate their own operational amplifier. They not only save the user the trouble of reconfiguration but also reduce the frequency of erroneous patching.
- Drift Compensation-type Operational Amplifier
  The drift compensation-type operational amplifier eliminates the necessity of offset adjustment prior to use. Further, there is no fear that offset or drift will occur during use.

ADAC 480, ANALOG COMPUTER

- Color Prepatch Board
  The input and output terminals are colored and marked according to the computing elements for ease of identification. As these input and output terminals help prevent erroneous patching, even a beginner can patch easily.
- Patching after Prepatch Board Installation Is Possible
  The computing element input-output pins are constructed so that the patch connections can be changed even after patch board installation (that is, during computation).
- Easy Potentiometer Setting
  Each potentiometer setting can be made merely by flipping down the CAL switch. The setting will appear directly on the DVM.
- Addressing and Data Setting Through the Keyboard
  Addressing for reading the computing elements and digital potentionmeter coefficient setting can be easily accomplished through the keyboard. The address, output value, and setting are indicated on the respective digital display.
- Digital Setting Interval Timers
  The interval timers A, B, and C for use in repetitive operation can be individually set with two-digit switches with a high degree of precision.
- Time Sweep Signal Generation Capability
  During the time set by the interval timer B, a time sweep signal for sweeping from −1 MU to +1 MU is automatically generated. This signal is particularly of use as a time axis signal for the CRT and X-Y recorder.
- Program Setup Confirmation Capability
  The program setup check system permits easy checking of the program set up on the patch board.
  Synchronization of analog modes IC, OP and HO with logic modes LOAD, RUN and STOP, and any desired combination of these modes can be accomplished through patching in the control unit installed on the patch panel.
- Easy Connection of the External Signal Source to the Output
  Since the computation system is basically of the voltage-analog type, these computers do not need any special interface circuit when exchanging signals with external devices.

- **Complete Protection of All Circuits**
  All computing element inputs and outputs as well as reference voltage and power supply outputs are electrically protected. All circuits are therefore completely protected against damage due to erroneous patching.

GENERAL SPECIFICATIONS

Computing method:	One-shot low-speed operation, low-speed operation, high-speed operation, ultra-high speed repetitive operation, low-speed automatic operation, high-speed automatic operation, ultra-high speed automatic operation, analog/hybrid operation
Connection method:	Color prepatch board connection
Reference voltage:	+1 MU: +10V, -1 MU: -10V, Accuracy: ±0.05%
Setup check voltage:	±0.01, ±0.1, ±1.0 MU
Control voltage:	+2.4 to 5 V: Logic value "1" 0 to +0.8 V: Logic value "0"
Analog operation mode:	One-shot: IC, OP, HO Repetitive: IC-OP (2-mode), IC-OP-HO (3-mode)
Logic operation mode:	LOAD, RUN, STOP
Repetitive operation time:	100 μsec to 9.9 sec
Static accuracy:	Linear elements: ±0.05% Nonlinear elements: ±0.05 to ±0.5%
Dynamic accuracy:	Cycle test values: ±0.04%/cycle, ω=1 rad/sec ±0.04%/cycle, ω=10 rad/sec ±0.1%/cycle, ω=100 rad/sec ±0.8%/cycle, ω=1000 rad/sec
Time scale:	1, 10, 100, 1000
Operational amplifier:	Type: FET chopper drift compensation type Gain: 105 dB Frequency characteristics: 8 MHz (unity gain) Drift: 5 μV/8H (summing amplifier when the magnification is 1.)
Environmental conditions:	Temperature: 5 to 40°C (the performance is guaranteed at 23 ±3°C) Humidity: 30 to 80%RH (the performance is guaranteed at 65 ±10%RH)
Power requirements:	100V AC ±10%, 50/60 Hz, Approx. 500 VA
Dimensions:	Approx. 860(H) x 1240(W) x 655(D) mm
Weight:	Approx. 250 kg (C-type configuration)

ADAC 480, ANALOG COMPUTER

STANDARD CONFIGURATIONS (A to C)

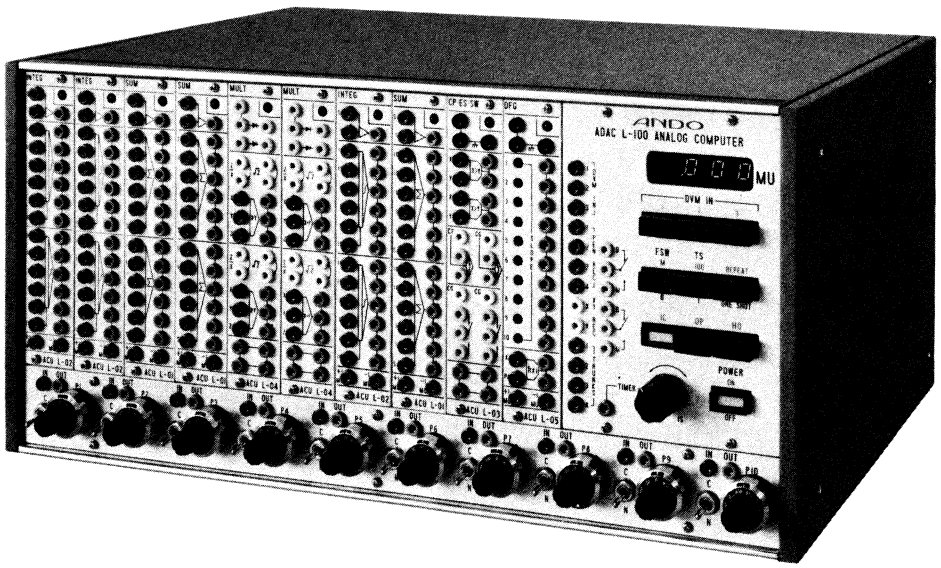
No.	Symbol	Name of Unit	Model	No. of Computing Elements	No. of Computing Elements Incorporated			Remarks
					A	B	C	
1	Σ	Summing Amplifier Unit	ACU-321	4	12	16	24	
2	J	Summing Integrator Unit	ACU-322	2	12	18	24	
3	A	Universal Operational Amplifier Unit	ACU-025	4	4	4	8	
4	P	Potentiometer I/O Unit	ACU-027	1 set	4	6	7	Including ±1 MU outputs.
5	P.P	Potentiometer Panel	ACP-071	10	40	60	70	Two 10-turn potentiometers and one 8-turn potentiometer
6	P.P	Potentiometer Panel	ACP-051	10				Ten 10-turn potentiometers
7	M	Multiplier-divider Unit	ACU-024	2	4	6	10	
8	FG	DFG I/O Unit	ACU-028	1 set	1	1	1	
9		F.DFG Panel	ACP-080	2	2	4	6	Break-point fixed
10		V.DFG Panel	ACP-054	1				Break-point variable
11	T.D	Time Delay Panel	ACP-060	1				
12	CP	Comparator Unit	ACU-023	8			8	Including 2 relays
13	ES	Electronic Switch Unit	ACU-026	8			16	Including 2 relays
14	CE	Comparator/Electronic Switch Unit	ACU-038	4/4	4/4	4/4		Including 2 relays
15	AZ	Auxiliary Impedance Unit	ACU-029	1 set		1	1	
16	RO	Output Unit	ACU-288	1 set	1	1	1	
17	TS	Trunk Unit	ACU-039	1 set	1	1	1	
18	CL	Control Unit	ACU-287	1 set	1	1	1	
19	LG	Logic Gate Unit	ACU-033	10	10	10	20	
20	FF	G.P.R Unit	ACU-034	1 set	1	1	2	4 FF's and two gates
21	CR	Counter Unit	ACU-035	2	2	2	4	
22	LI	Logic Indicator	ACP-053		1	1	1	
23		Control Panel	ACP-230		1	1	1	
24		Computer Proper			1	1	1	
25		Prepatch Board	ACC-063		1	2	2	
26		Patch Cable Set	ACC-064		2	3	4	

NOTES
(1) In addition to the computing elements mentioned above, the following units are available as options.
Saturation/dead-zone/absolute value unit, sinX•cosX generator unit, track hold unit, function switch unit and panel.
(2) A digital potentiometer panel, its I/O unit, and a hybrid trunk unit can also be incorporated in the ADAC computers as the hybrid computer systems.
(3) The ADAC 480 can accommodate up to 48 units, 8 potentiometer panels, and 5 DFG panels

20 TRAINING SETS FOR EDUCATIONAL USE

ANALOG COMPUTER
ADAC L-100

- *The ADAC L-100 does not need a skilled operator, therefore anyone can operate it.*
- *ADAC L-100 capacity can be expanded.*
- *The ADAC L-100 is moderately priced, small and compact.*



FEATURES

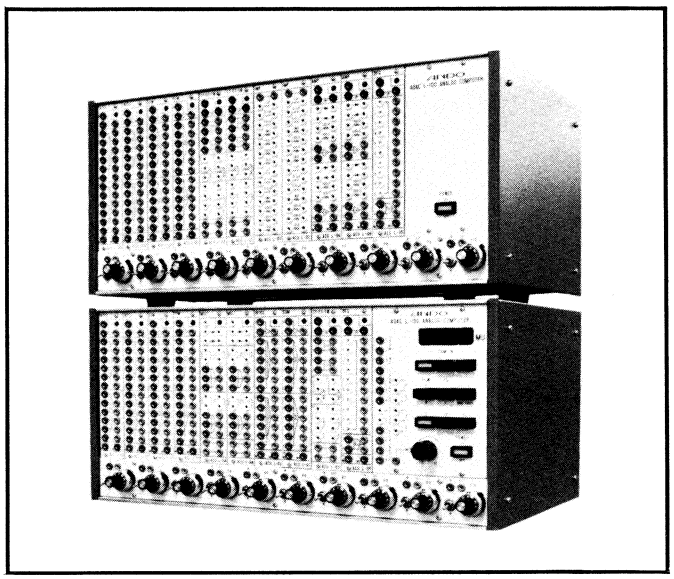
- As computing unit symbols are marked on the patch board, any desired operational circuit can be realized by merely patching-in according to the patch board.
- Pin contacts are colored for identification in order to prevent erroneous patching.
- All computing units are protected from damage due to erroneous patching.
- Potentiometer setting coefficients and computing module outputs can be directly read on the digital voltmeter on the front panel.
- Low power IC s are used throughout the computing modules and control circuits to make them more compact and reduce power consumption.
- Patch cables are securely connected to the inputs and outputs of computing units by spring action so that computer operation is reliable and outstandingly good reproducibility of solutions is obtained.
- Types and numbers of operating units can be determined to suit various data processing purposes, and two or more units of the ADAC L-100 can be operated in tandem according to the volume of data to be processed.
- The ADAC L-100 can be controlled from external equipment.

MODEL ADAC L-100, ANALOG COMPUTER

GENERAL SPECIFICATIONS

Operating mode: High speed operation, low speed operation, repetitive operation; externally controllable.
Programming: Patching on fixed patch panel.
Reference voltage: ±10V.
Output current: ±4mA (typical).
Logic voltage: +2.4 to 5V for logical value "high"; 0 to +0.8V for logical value "low".
Time scale: 1, 100.
Computing mode: ONE SHOT (IC, OP, HO); REPEAT (IC–OP).
Computing time of repetitive operation: 10ms to 1s, continuously variable.
Static accuracy: ±0.1 to ±0.3% for linear components; ±0.1 to ±1.5% for non-linear components.
Dynamic accuracy: (Circle test value) ±0.1%/cycle, ω=1.
Drift: 50μV/day.
Noise: 2mV (rms) or less.
Environmental conditions:
Temperature: 5 to 35°C; specifications apply at 23 ± 3°C.
Relative humidity: 35 to 80%; specifications apply at 65 ± 10%.

Power requirements: 100V AC, 50/60Hz; approx. 35VA.
Dimensions and weight: Approx. 200(H) x 425(W) x 250(D) mm; approx. 15kg (D setup).

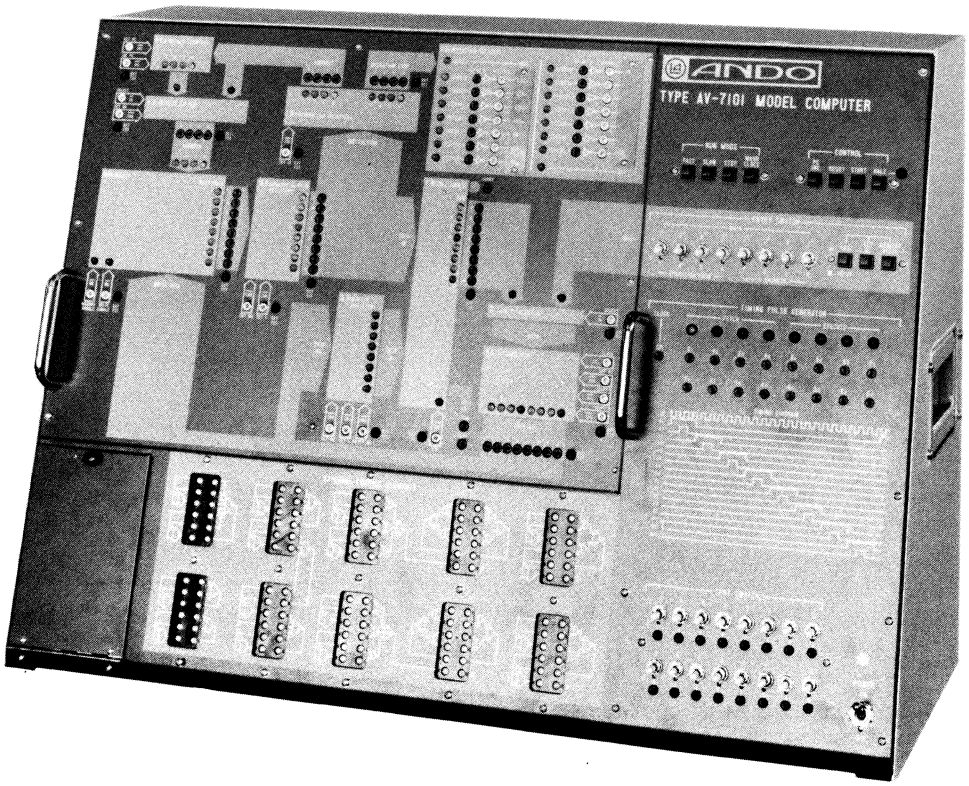


SETUP SELECTION GUIDE (Setup Example A-G)

Table below shows the quantity of units and components of each setup. (: the quantity of components)

Unit		Setup Examples													
Type	Name	A		B		C		D		E		F		G	
ACU L-01	Summing Amplifier Unit	1		1		1		2		3		4		4	
	Summing Amplifier 2		2		2		2		4		6		8		8
	Inverter 1		1		1		1		2		3		4		4
ACU L-02	Summing Integrator Unit	1		1		2		3		4		5		6	
	Summing Integrater 2		2		2		4		6		8		10		12
	Inverter 1		1		1		2		3		4		5		6
ACU L-03	Comparator/Electronic Switch Unit					1		1		1		1		2	
	Comparator 2						2		2		2		2		4
	Electronic Switch 2						2		2		2		2		4
	Function Relay 2						2		2		2		2		4
ACU L-04	Multiplier Unit			1		1		1		1		3		4	
	Multiplier 2				2		2		2		2		6		8
	Free Diode 2				2		2		2		2		6		8
ACU L-05	Diode Function Generator Unit					1		1		1		2		2	
	D F G 1						1		1		1		2		2
ACU L-06	Universal Operational Amplifier Unit			1		1		1		1		1		2	
	Universal Operational Amplifier 2				2		2		2		2		2		4
	Free Resistor 4				4		4		4		4		4		8
	Free Diode 4				4		4		4		4		4		8
ACU L-07	Auxiliary Impedance Unit			1		1		1		1		1		1	
	Free Resistor 8				8		8		8		8		8		8
	Free Capacitor 6				6		6		6		6		6		6
ACC L-410	Patch Cable Set	1		2		2		3		3		3		4	
	Patch Cable 50		50		100		100		150		150		150		200
ACC-L-400	Basic Frame	1		1		1		1		1		1		1	
	Potentiometer 10		10		10		10		10		10		10		10
	Digital Voltmeter 1		1		1		1		1		1		1		1
	Timer 1		1		1		1		1		1		1		1
	Function Relay 2		2		2		2		2		2		2		2
ACC L-420	Expansion Frame									1		1		1	
	Potentiometer 10										10		10		10

MODEL COMPUTER
TYPE AV-7101



The AV-7101 Model Computer is designed to allow students to acquire a fundamental knowledge of digital computers through experiments. A computer can process an aimed job when its software and hardware are suitably engaged with each other. It is, therefore, very important for persons who are engaged in the computer and its peripheral units design and maintenance as well as in the development and design of software, to understand the relationship between the logical configuration and programs which are the basic techniques of the computer. This equipment has various features as listed below, and it permits learning the operation principle of the computer correctly within a short period.

FEATURES

- The computer is operated merely by turning on the power switch. Programs can easily be written and executed by switch operation.
- The front panel graphically displays the basic circuits of the computers, and is provided with lamps indicating the status of signals at each portion of the circuits. These features allow students to understand the relation between the information flow and control signals of the computer.
- The execution speed of the computer is selectable to FAST or SLOW, and it can also be set to the one-step operation, one-state operation, etc., so that training can be advanced at an optimum speed for learning.
- The basic logical operation in major circuits can be confirmed by separating major component circuits of the computer from the other portions.
- Ten control instructions are prepared for the computer. Also, six control instructions can be added by combining these control signals.
- The AV-7102 large display panel is available as an option. It is useful when many students learn computer operation at the same time.

TYPE AV-7101, MODEL COMPUTER

TRAINING SCHEDULE

1 Experiment of the relation between binary system and hexadecimal system
2 Programming experiment by using instruction words
3 Experiment of executing process of instructions (fetch/excute cycles)
4 Programming experiment
5 Functional experiment of gate circuit
6 Functional experiment of register
7 Functional experiment of counter
8 Functional experiment of shift register
9 Functional experiment of full adder
10 Functional experiment of instruction decorder
11 Functional experiment of memory
12 Experiment by external control circuit
13 Other different experiments with additional instructions

SPECIFICATIONS

Operation system:	Binary 8-bit parallel addition system.
Word length:	Fixed word length of one word/8 bits.
Composition of instructions:	Instruction part 4 bits + address part 4 bits.
No. of instructions:	16 max.
Memory capacity:	8 bits x 16 words.
Input/output devices:	Input: 8 snap switches. Output: Accumulator (AC) data indicator lamps.
Execution mode:	FAST, SLOW, STEP, MANU CLOCK.
Clock time:	FAST: Approx. 0.1ms. SLOW: Approx. 300ms.
Machine cycle:	FETCH cycle, EXECUTE cycle. 4 states each. 1 state: 3 clock time.
Power consumption:	Approx. 30VA (AV-7101 mainframe only). Approx. 100VA (with AV-7102 combined).
Power requirements:	100V AC ±10%, 50/60Hz.
Dimensions:	Approx. 470(H) x 650(W) x 270(D)mm.
Weight:	Approx. 13.5kg.

Accessories supplied:

Patching cable, white	10 pcs.
Patching cable, brown	10 pcs.
Patching cable, yellow	10 pcs.
Patching cable, red	10 pcs.
Patching cable, green	10 pcs.
Short plug	15 pcs.
Vinyl cover	1 pc.

OPTION

TYPE AV-7102 DISPLAY PANEL

This display panel is designed to display the operating conditions of the model computer in an enlarged form with AV-7101 Model Computer combined by using a connecting cable.

SPECIFICATIONS

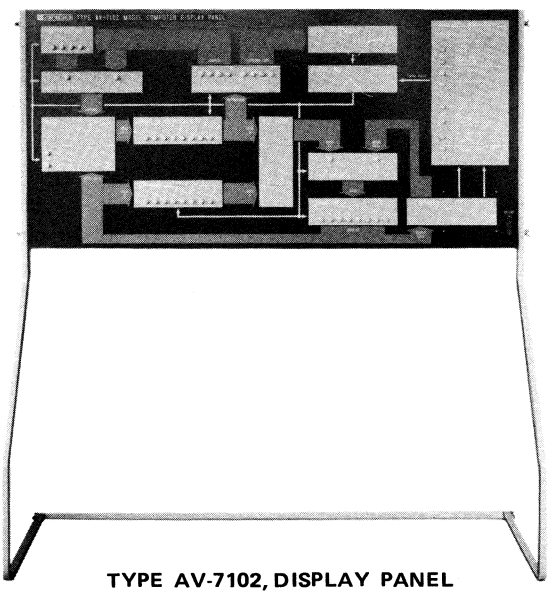
Lamp indication items:

Machine cycle display	8
Program counter display	4
Address buffer display	2
Memory enable, write enable display	2
Memory buffer register display	8
Buffer register display	8
Instruction register display	8
Accumulator display	8
Data selector display	2

Dimensions:	Approx. 1800(H) x 1650(W) x 600(D)mm.
Weight:	Approx. 24kg.

Accessories supplied:

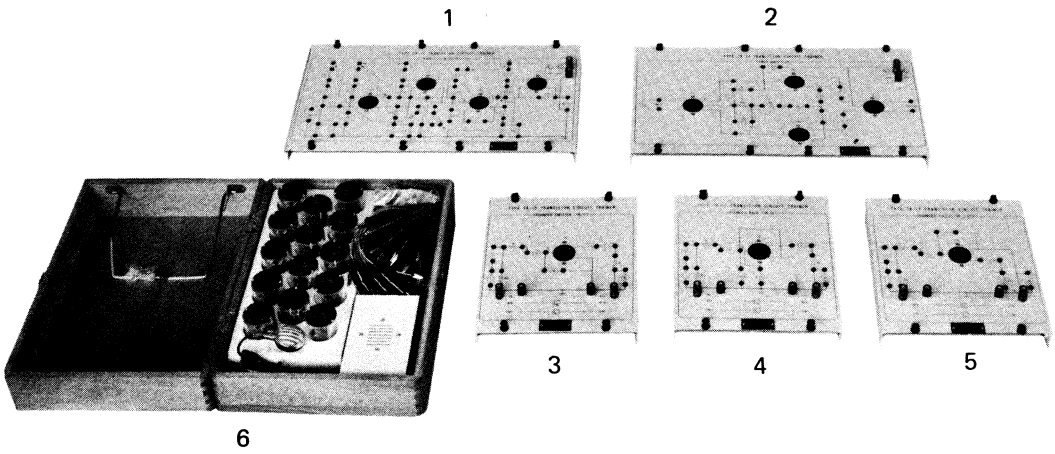
60-pin connecting cable	1 pc.
Vinyl cover	1 pc.



TYPE AV-7102, DISPLAY PANEL

TRANSISTOR CIRCUIT TRAINER

TYPE TA-13



In the photo:

1. Amplifier & oscillator
2. Power amplifier
3. Grounded emitter circuit
4. Grounded base circuit
5. Grounded collector circuit
6. Accessory kit

As a result of remarkable progress made in semiconductor technology, the size of electronic machinery and appliances has been reduced dramatically and the reliability of their performance has been increased considerably. Today, transistors which have supplanted vacuum tubes are finding wider use in various electronic applications. The TA-13 designed for educational purposes is effective in the initiation of beginners into transistor circuit technology. The graphic layout of the panels and a wide selection of circuit constants allow beginners to perform quick experiments with ease from various angles. As the dimensions of the TA-13 experimental panels are in common with those of the Ando's pulse circuit trainer PUO-35 and the modulation/demodulation circuit trainer MD-2, the TA-13 experimental panels can be mounted on the racks of the PUO-35 and MD-2.

FEATURES

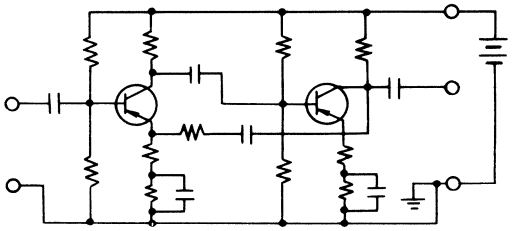
- The experimental circuit is clearly shown on each front panel, and its wiring is provided on the back of each panel
- Since each experiment can be performed in the wiring in accordance with its neat circuit diagram on the panel, a troublesome wiring is not demanded for setting-up.
- Circuit parts such as resistors, capacitors, and transistors are all of the plug-in type so that a desired circuit constant can be selected for every circuit.
- Transistors and transformers are housed in rugged molded cases of the plug-in type. As soldering is not needed for making an experimental circuit, there is no possible damage that is caused to the transistors and transformers due to erroneous wiring or inadvertent operation. Should the transistor be damaged by accident, it can be replaced quite easily because it is of the plug-in type.

TYPE TA-13, TRANSISTOR CIRCUIT TRAINER

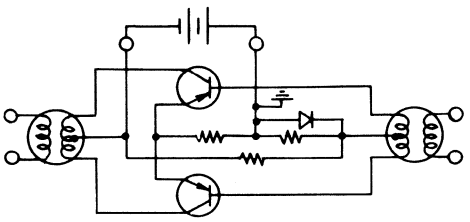
TRAINING SCHEDULE

1. Measurement of static characteristics of transistors and demonstration of transistor parameters
2. Study of the circuit constants based on the dynamic characteristics of transistors
3. Determination of constants of a RC-coupled voltage amplifier circuit by common-emitter connection
4. Comparison of transformer coupling and RC coupling in a voltage amplifier circuit
5. Method of negative feedback in an amplifier circuit and its characteristics
6. Design of a power amplifier circuit
7. Design of a R-C oscillator circuit
8. Assembly of a loud speaker system

CIRCUIT EXAMPLES



R-C coupled type voltage amplifier circuit



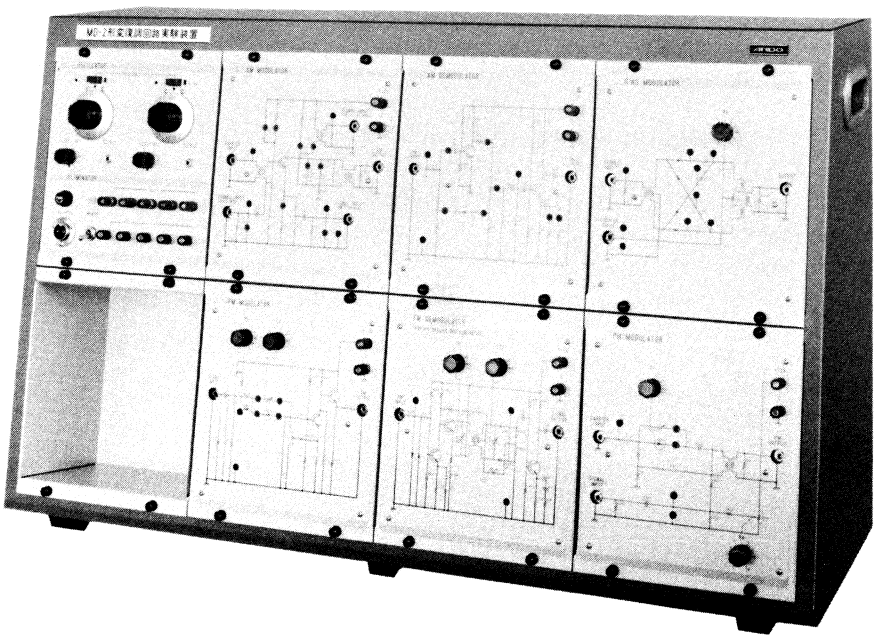
Push-pull type power amplifier circuit

COMPOSITION

	Name			Quantity	Remarks
Panels	Grounded emitter circuit			1	Dimensions: Approx. 240 x 210 x 40 mm Weight: Approx. 0.5 kg
	Grounded base circuit			1	Dimensions: Approx. 240 x 210 x 40 mm Weight: Approx. 0.5 kg
	Grounded collector circuit			1	Dimensions: Approx. 240 x 210 x 40 mm Weight: Approx. 0.5 kg
	Amplifier & oscillator			1	Dimensions: Approx. 240 x 420 x 40 mm Weight: Approx. 1 kg
	Power amplifier			1	Dimensions: Approx. 240 x 420 x 40 mm Weight: Approx. 1 kg
Attachments	Accessory kit	Accessory box		1	Dimensions: Approx. 240 x 310 x 85 mm Weight: Approx. 2.5 kg (with accessories)
		Transistor	2SA-636	4	2 with acrylic resin case
			2SA-641	4	2 with acrylic resin case
			2SC-1098	4	2 with acrylic resin case
			2SC-923	4	2 with acrylic resin case
		Diode 1S953		2	
		Transformer		6	With acrylic resin case
		Fixed resistor		34	
		Fixed capacitor		15	
		Microphone		1	Crystal type
		Speaker		1	Dynamic type
		Connecting cable		35	Fifteen 10 cm long cables, twenty 20 cm long cables
		Connecting cable		15	50 cm long
Complementary instruments available	DC voltmeter			1	Rating 15 V and 30 V
	DC ammeter			1	Rating 0.5 mA
				1	Rating 25 mA and 50 mA
	Sine wave oscillator			1	20 Hz to 50 kHz, 600Ω (Ando's Type TCO-48 Oscillator recommended)
	Oscilloscope			1	10 Hz to 100 kHz
	Electronic voltmeter			1	1 mV to 30 V
	Battery or stabilized DC power supply			1	1.5 V
				1	12 V
				1	20 V

MODULATION/DEMODULATION CIRCUIT TRAINER

TYPE MD-2



The MD-2 is a modulation/demodulation circuit trainer for educational purposes. It allows students to familiarize themselves with the principle of carrier communication techniques through the experimental demonstrations of modulation/demodulation circuits and AM/FM circuits, etc.

FEATURES

- The MD-2 employs fully solid-state circuits and can perform experiments similar in contents to the performances of practical modulation/demodulation circuits.
- Six different experimental units (panels) are provided. Therefore, fundamental experiments can be performed separately in groups, and applied experiments are also possible through combination of the units.
- Each experimental unit (panel) shows graphically the features of basic circuit on the front panel. Therefore, it allows students to easily understand the principle of the circuit.
- The condition of experimental circuits can be easily changed by using accessory short-plugs.
- The MD-2 has internal sine wave oscillators (0.15 to 15 kHz, 15 to 1500 kHz) and DC output circuits.

TYPE MD-2, MODULATION/DEMODULATION CIRCUIT TRAINER

TRAINING SCHEDULE

1. Experiments of amplitude-modulations at base, collector and emitter of transistors
2. Experiments of demodulation circuits made up of transistors and diodes
3. Frequency modulation experiments
4. Frequency demodulation experiments
5. Phase modulation experiments
6. Experiments of modulation and demodulation with a ring modulation circuit
7. Combined modulation and demodulation experiments
8. Other applied experiments

CIRCUIT EXAMPLES

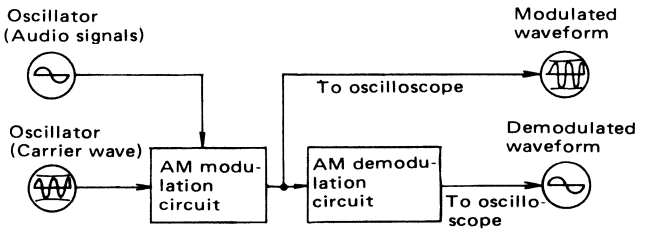


Fig. 1 AM Modulation

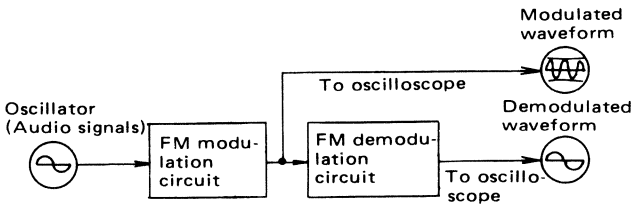


Fig. 2 FM Modulation

COMPOSITION

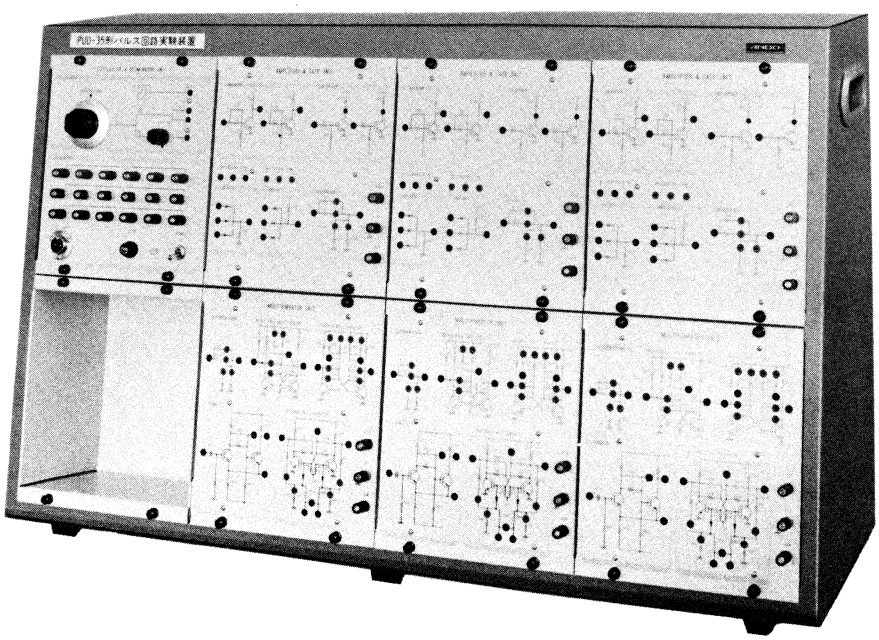
	Name	Quantity	Remarks
Experimental unit	AM modulator	1	Dimensions (each unit): Approx. 240(H) x 210(W) x 50(D) mm.
	AM demodulator	1	
	FM modulator	1	
	FM demodulator	1	
	PM modulator	1	
	Ring modulator	1	
	Oscillator and eliminator	1	Dimensions: Approx. 240(H) x 210(W) x 50(D) mm. The unit consists of two oscillator circuits (0.15 to 15 kHz, 15 to 1500 kHz) and five DC output circuits (+12V).
Accessories supplied	Short plug	40	
	Power cable	1	
	Patch cable	21	
	Fuse (0.5A)	1	

GENERAL

Power requirements: 100V AC, 50/60 Hz.
Mainframe dimensions: Approx. 530(H) x 880(W) x 300(D) mm.
Complementary instruments required: 2MHz dual-trace oscilloscope and frequency counter.

PULSE CIRCUIT TRAINER

TYPE PUO-35



Digital circuit technology has been receiving increasing attention as a means to achieve high accuracy and efficiency of measurements and control. The basis of the digital circuit technology is the pulse circuit. The PUO-35 is so designed as to provide a variety of pulse circuits for educational purposes. It allows beginners to familiarize themselves with the principle of the pulse circuit operation through experimental demonstration of the relation between circuit constants and waveforms.

FEATURES

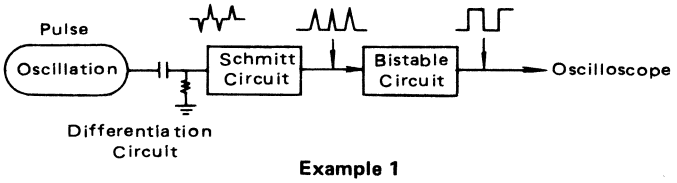
- The PUO-35 provides the amplifier & gate units (panels) and the multivibrator units (panels), three unit each, and each unit incorporates several experimental circuits. Therefore, fundamental experiments can be performed separately in groups, and applied experiments are also possible through combination of the units.
- Each experimental unit (panel) shows graphically the features of basic pulse circuits on the front panel. Therefore, it allows students to easily understand the principle of the pulse circuit operation.
- Circuit parts such as resistors, capacitors and transistors can be easily selected by using accessory short-plugs.
- The oscillator & eliminator unit contains 0.15 to 1.5 kHz sine wave/square wave oscillator circuit, a 1 Hz square wave oscillator circuit, and six eliminator circuits.

TYPE PUO-35, PULSE CIRCUIT TRAINER

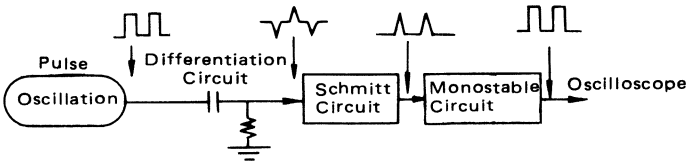
TRAINING SCHEDULE

Experiment 1	The relation between differentiation-integration circuit constants and waveforms
Experiment 2	The relation between input signal level of the Schmitt trigger circuit and output waveform
Experiment 3	The relation between astable circuit constant and repetitive cycle
Experiment 4	The relation between monostable circuit constant and pulse width
Experiment 5	Storage and half-cycle operation of bistable circuit
Experiment 6	Functions of AND circuit and OR circuit
Experiment 7	Inverter circuit operation
Experiment 8	LED driver circuit operation
Experiment 9	Combination of fundamental pulse circuits
Experiment 10	Other applied experiments

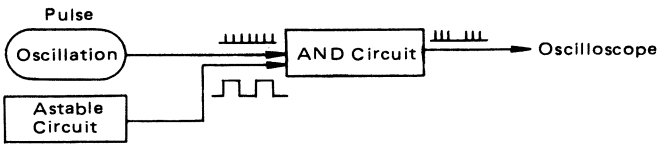
CIRCUIT EXAMPLES



Example 1



Example 2



Example 3

CONFIGURATION

Name	Quantity	Quantity of circuits included in one unit	Dimensions & weight
Multivibrator unit	3	Differentiation circuit .....1 Schmitt circuit .....1 Astable circuit .....1 Monostable circuit .....1 Bistable circuit 1	Approx. 240H x 210W x 50D mm. Approx. 0.5 kg.
Amplifier & gate unit	3	AND circuit .....1 OR circuit .....1 Integration circuit .....1 Inverter circuit ..... 2 LED driver circuit 2	Approx. 240H x 210W x 50D mm. Approx. 0.5 kg.
Oscillator & eliminator unit	1	1 Hz square wave oscillator circuit ..... 1 0.15 to 1.5 kHz square-wave/ sine-wave oscillator circuit..... 1 ±12V DC output circuit..... 6	Approx. 240H x 210W x 150D mm. Approx. 2 kg.

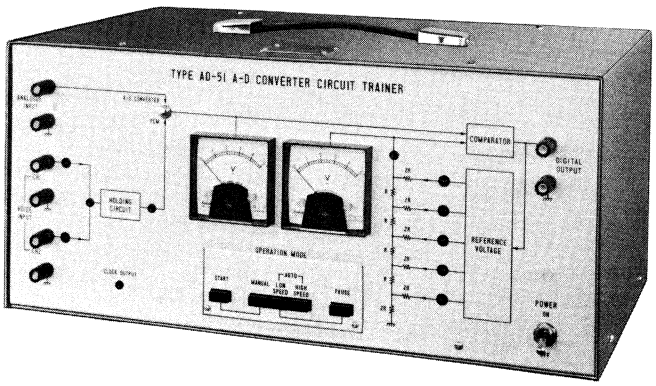
GENERAL

Power requirements: 100V AC, 50/60 Hz.
Cabinet dimensions: Approx. 530(H) x 880(W) x 300(D) mm.
Cabinet weight: Approx. 15 kg (excluding component units).
Accessories supplied: 30 short-plugs, 27 patch cables, 19 power cables, one fuse.
Complementary instrument available: One dual trace oscilloscope.

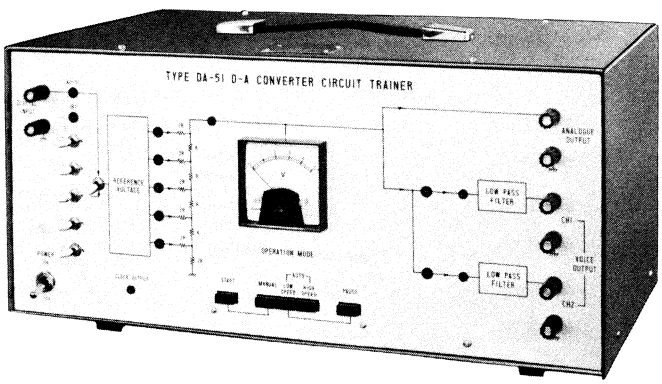
A-D/D-A CONVERTER CIRCUIT TRAINERS

TYPES AD-51/DA-51

- *For studying principles of A-D and D-A conversion*
- *For simulation experiments of PCM communications*



TYPE AD-51



TYPE DA-51

The AD-51 and DA-51 are so designed that they can be independently used in various types of experiment to allow beginners to familiarize themselves with the principles of A-D and D-A conversion, and are so constructed that they fit each other to perform more efficient experiments. In addition, they are provided with an auxiliary circuit for simulation of PCM (pulse-code modulation) communication.

PCM communications are based on the principle that transmitting signals are converted from analog to digital form by means of coding at a transmitting end and demodulated from digital to analog form at a receiving end. Being highly efficient and reliable as a means of communications, PCM system has come into practical use in such fields as public telephony and space communications. Students can easily understand the principles of A-D and D-A conversion through the simulation experiment of PCM communications.

The main circuits of the AD-51 and DA-51 are graphically shown on the front panel, and the processing operations of conversion are indicated by lamps.

TYPES AD-51/DA-51, A-D/D-A CONVERTER CIRCUIT TRAINERS

AD-51 A-D CONVERTER CIRCUIT TRAINER

A-D conversion can be accomplished in three modes, and each mode can be selected at the flick of a switch. The conversion modes consist of:

- Continuous conversion (repetition)
- Single conversion (single sweep), and
- Manual speed-controlled conversion

The D-A conversion output is indicated on the front panel meter in response to analog input voltage, and therefore students can confirm input and output by comparison. Terminals for connection of an oscilloscope are provided so that the principles of conversion can be visually learned by observing changes in the waveform.

SPECIFICATIONS

Type:	Successive comparison type.
Input:	0 to +5 V DC, 2 sets of AC terminals for PCM communication simulation.
Output:	Code "1" (approx. +5V); code "0" (approx. 0 V).
Output code:	Binary 5 bits.
Converting speed:	Approx. 80 μs.
Dimensions:	Approx. 200(H) x 440(W) x 250(D) mm.
Weight:	Approx. 5 kg.
Power requirements:	100V AC, 50/60 Hz.
Accessories supplied:	5 connecting cables (1 m long each), 1 fuse (0.5 A).

DA-51 D-A CONVERTER CIRCUIT TRAINER

D-A conversion can be accomplished in three modes, and each mode can be selected at the flick of a switch. The conversion modes consist of:

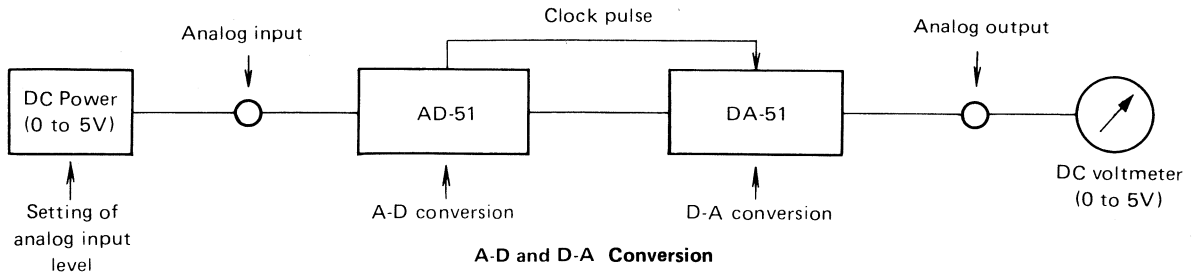
- Continuous conversion (repetition)
- Single conversion (single sweep), and
- Manual speed-controlled conversion

A digital input from an external source is usually applied to the DA-51, but D-A conversion can be accomplished by the DA-51 alone, because it has a circuit which generates an arbitrary simulation input according to switch-setting.

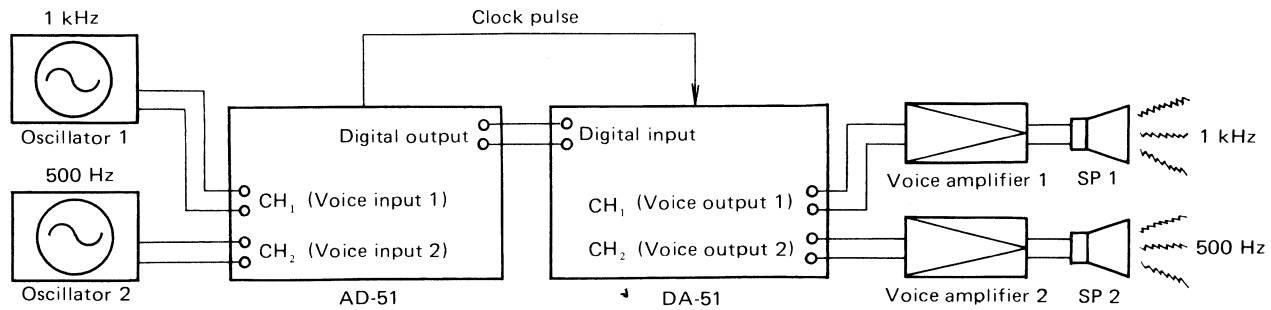
SPECIFICATIONS

Type:	Clock synchronized current synthesis.
Input:	Code "1" (approx. +5V); code "0" (approx. 0 V).
Input code:	Binary 5 bits.
Output:	0 to +5 V DC, 2 sets of AC terminals for PCM communication simulation.
Converting speed:	Approx. 80 μs.
Dimensions:	Approx. 200 (H) x 440 (W) x 250 (D) mm.
Weight:	Approx. 5 kg.
Power requirements:	100V AC, 50/60 Hz.
Accessories supplied:	4 connecting cables (1 m long each), 1 fuse (0.5 A).

EXPERIMENT EXAMPLES



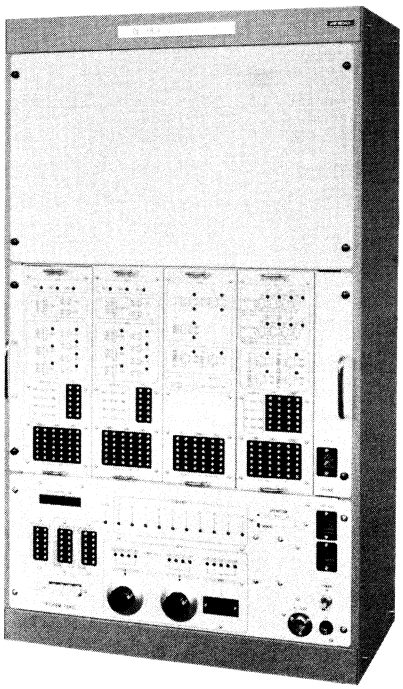
A-D and D-A Conversion



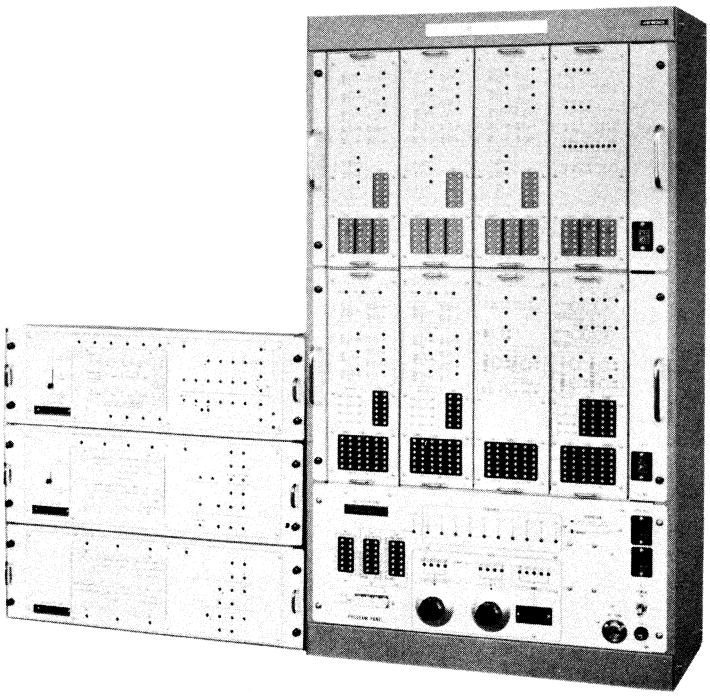
PCM Communication Simulation

DIGITAL CIRCUIT TRAINERS

TYPES DL-3A/3D



TYPE DL-3A



TYPE DL-3D

FEATURES

- **TTL utilized**
  Because the DL-3A/3D Digital Circuit Trainers utilize TTL, a practical knowledge of logic circuits can be acquired through experiments with this equipment.
- **Plug-in Units and Easy Connections with Patch Cables**
  Because functional circuit units which combine basic logic elements are available, sophisticated logic circuits can be easily configured by the use of patch cables.
- **Lamps Indicating the Status of Signals**
  The logic status of main logic elements is indicated by LED's so that the routing of signals can be visually confirmed.
- **Plug-in Units and Trunks**
  One trunk accommodates up to 4 plug-in units. Instead of installing individual units in a rack, they are first installed in a trunk and connected with patch cables. Then the trunk is fitted into the rack.
- **Clock Pulse Generation**
  Because clock pulses can be generated at any desired speed merely by switching from the automatic to the manual mode, circuit experiments can be performed at speeds suitable for individual requirements.
- **Display Panels**
  When display panels are used in experiments with operational binary circuits, lamps light to indicate processing operations corresponding to handwritten calculations. This function will serve to increase the understanding of students.

TYPES DL-3A/3D, DIGITAL CIRCUIT TRAINERS

CONFIGURATIONS

Components	Trainers and Num. of Components	
	DL-3A	DL-3D
Rack (with standard accessories)	1	1
Program panel	1	1
Trunk	1	2
Gates unit (1)	2	2
Flip-flops unit	1	1
Adders unit	1	1
Gates unit (2)	—	3
Counters unit	—	1
Filler panel	1	—
Display panel, binary parallel adder & subtractor	—	1
Display panel, binary serial adder & subtractor	—	1
Display panel, binary 2-bit multiplier	—	1
Special accessories	—	1

TRAINING SCHEDULE

Item	DL-3A	DL-3D
1. Logical component function experiment	●	●
2. Study of the application of Boolean algebra to logic circuits	●	●
3. Code conversion circuit experiment	●	●
4. Shift register circuit experiment	●	●
5. Counter circuit experiment	●	●
6. Half-adding circuit experiment	●	●
7. Full-adding circuit experiment	●	●
8. Complement circuit experiment	●	●
9. Coincident circuit experiment	●	●
10. Comparison circuit experiment	●	●
11. Operation of binary notation serial addition	●	●
12. Operation of binary notation serial subtraction	●	●
13. Operation of binary notation parallel addition	●	●
14. Operation of binary notation parallel subtraction	●	●
15. Operation of binary notation simultaneous multiplication	●	●
16. NAND logic analysis experiment		●
17. NAND logic composition experiment		●
18. Flip-flop logic circuit experiment		●
19. Parity check circuit experiment		●
20. Subtraction circuit experiment		●
21. Division circuit experiment		●

GENERAL

Dimensions:

Rack: Approx. 915(H) x 520(W) x 280(D) mm.
Display panel: Approx. 152(H) x 500(W) x 35(D) mm.
Unit (each unit of gates, flip-flops, adders, and counters):
Approx. 300(H) x 105(W) x 55(D) mm.

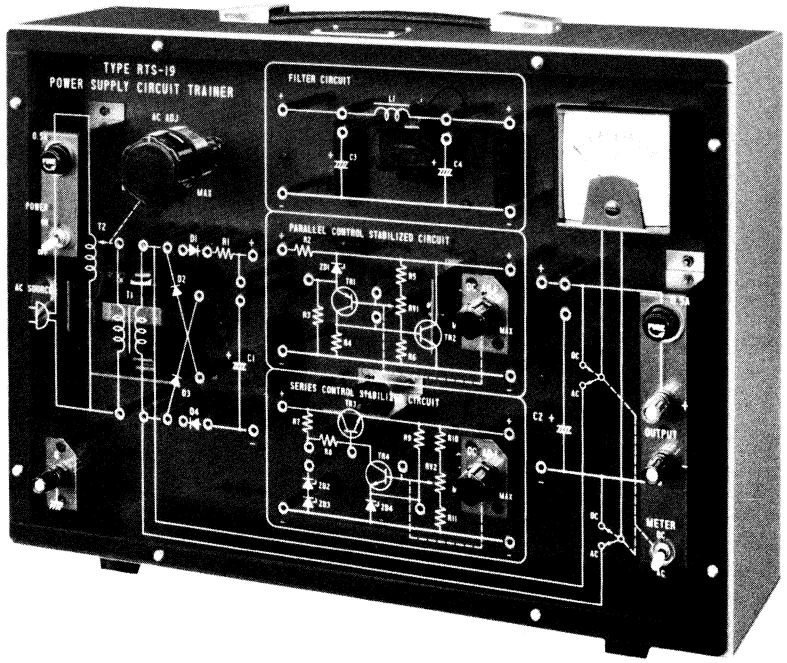
Weight:

DL-3A (including units): Approx. 29 kg.
DL-3D: Rack (including units), approx. 31 kg.
Display panel, approx. 1 kg (one panel).

Power requirements: 100V AC, 50/60 Hz.

POWER SUPPLY CIRCUIT TRAINER

TYPE RTS-19



If you are familiar with the characteristics of a rectified power supply circuit, you can skillfully use a rectified power supply or design its circuit with ease.

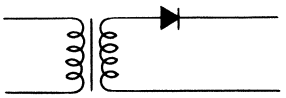
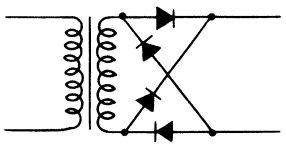
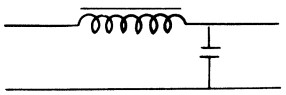
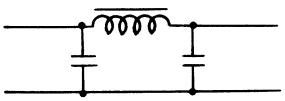
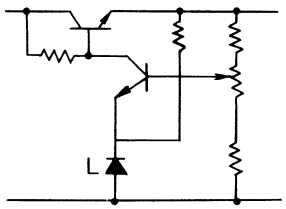
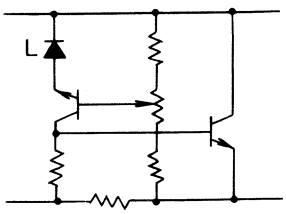
The RTS-19 is an educational experimental equipment for helping students learn the basic power supply circuit information from the rectifying circuit fundamentals to the stabilized power supply circuit with the voltage regulating function in relation to their characteristics.

FEATURES

- This equipment also serves as a DC stabilized power supply in practical applications. Its capacity is about 12V , 0.15 A.
- The test circuits are printed on the front panel and the circuit components which are located inside the cabinet at the positions corresponding to those of the printed circuits can be seen through the front panel. Students can easily understand how the circuits are made up.
- As various power supply circuits can be obtained in an instant just by changing connecting cables, students can learn the circuitry in a short time.
- As a voltage regulator and a voltmeter are incorporated into this equipment, variations in power supply voltage can be determined and experimental output voltage adjustment can be made without using any other complementary equipment.

TYPE RTS-19, POWER SUPPLY CIRCUIT TRAINER

TRAINING SCHEDULE AND CIRCUIT EXAMPLES

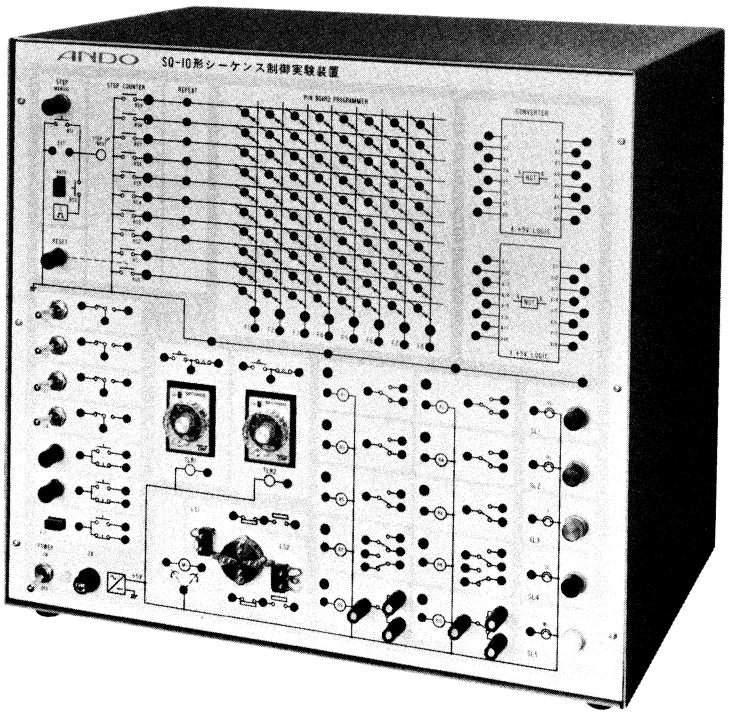
Training schedule	Circuit examples
1) Principle of the rectifying circuit and rectification characteristics	 Half wave rectifying circuit  Bridge rectifying circuit
2) Smoothing circuit constant and ripple voltage	 Smoothing circuit (choke input type)  Smoothing circuit (capacitor input type)
3) Principle of operation of the series control stabilized circuit	 Series control stabilized circuit
4) Principle of operation of the parallel control stabilized circuit	 Parallel control stabilized circuit
5) Measurement of voltage fluctuations	

GENERAL

Dimensions: Approx. 120(H) x 420(W) x 300(D) mm.
Weight: Approx 6 kg.
Accessories supplied: 26 connection cables. Two fuses (0.5A each).
Complementary instruments available: Oscilloscope, voltmeter, ammeter, and slide rheostat (one set each).

SEQUENTIAL CONTROLLER

TYPE SQ-10



Now, sequence control techniques are commonly used in traffic signal circuits and elevator control equipment, and electricians and technicians who maintain such equipment are now required to become familiar with sequence control techniques.

The SQ-10 sequence controller is designed to allow students to acquire a fundamental knowledge through the simulation of data necessary for designing and analyzing various sequence control circuits.

FEATURES

- The front panel graphically displays control circuits and composite elements, which lets beginners easily learn sequence control fundamentals.
- Lamps indicate the status of main circuit components. Because simulation can be achieved at slow speeds, the control function sequences can be visually confirmed.
- The SQ-10 is designed so that any desired circuit can be quickly configured with patch cables. This feature allows students to perform various interesting tests by combining the SQ-10 with other equipment or by changing the object controlled.
- An experiment guide book with examples of experiments and technical information for performing experiments is available on request.

TYPE SQ-10, SEQUENTIAL CONTROLLER

APPLICATIONS

The SQ-10 Sequential Controller is designed for the following purposes.

(1) To allow students to familiarize themselves with techniques for reproducing and analyzing sequence control circuits.

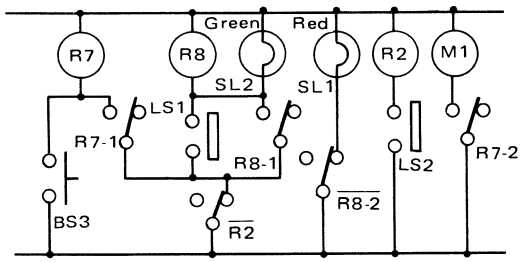
(2) To allow students to confirm various sequence control circuit functions in order to clarify the advantages and disadvantages of sequence control and to acquire circuit design techniques.

(3) Because the SQ-10 is also designed to serve as a sequencer for practical applications, it can also be utilized for various applications requiring sequence control.

TYPES OF EXPERIMENTS

The sequential controller can perform various experiments, both fundamental and applied. The following is a partial listing of experiments which this equipment can perform.

1. NOT, AND and OR circuits
2. NAND and NOR circuits
3. Selfhold circuit
4. Time-limit relay circuit
5. Simplified contact circuit
6. Starting circuit (the circuit preceding another circuit in sequence of operation)
7. Rotary direction control of an electric motor
8. Detecting circuit for defective rotation of an electric motor
9. Pushbutton traffic light circuit



Circuit Example

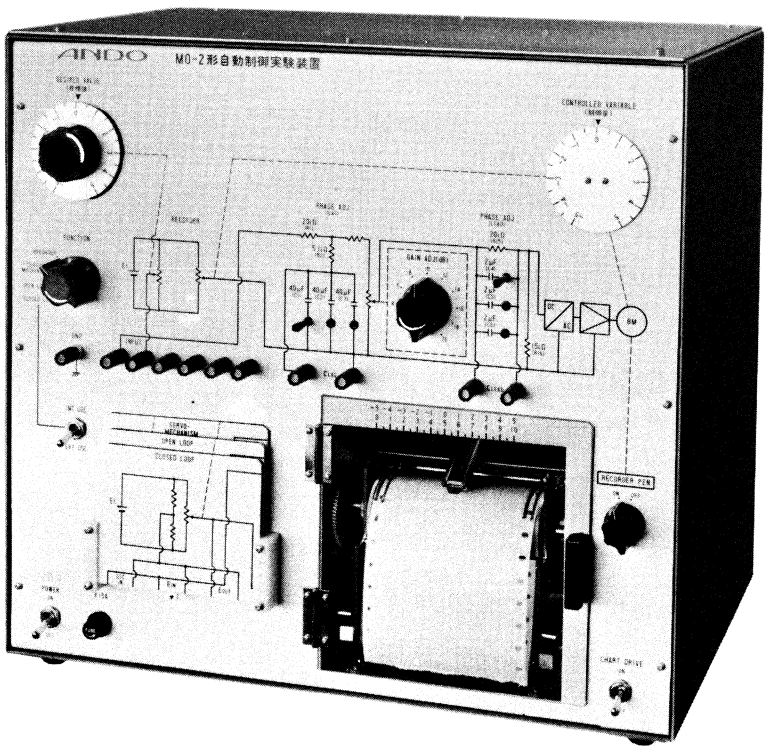
10. Start and stop operation of a belt conveyor

GENERAL

Power requirements:	100V AC, 50/60Hz.
Dimensions:	Approx. 450(H) x 500(W) x 280(D) mm.
Accessories supplied:	35 patch cables, 30 plugs.

AUTOMATIC CONTROL TECHNIQUE TRAINER

TYPE MO-2



The MO-2 is an experimental equipment for helping students learn the fundamentals of automatic control techniques through experimentation.

Automatic control techniques can be divided into process control techniques, servomechanism techniques and automatic adjustment techniques according to practical applications. This equipment helps students learn about servomechanism techniques which are widely used in industrial applications for controlling mechanical positioning. Servomechanisms generally have feedback loops for achieving accurate, rapid responses to target values. Because control functions can be theoretically analyzed and visually confirmed, servomechanisms provide an effective means for learning about automatic control principles.

FEATURES

- Fundamental automatic control experiments can be quickly performed. Desired experimental circuit can be selected just by touching one switch.
- The front panel graphically displays experimental circuits incorporated in the equipment. Accessory guide plates which graphically show each experimental circuit are also provided in order to help students obtain a better understanding of experiments. Circuit components can be seen through the top panel.
- A wide range of experiments can be performed. In addition to fundamental experiments, various other experiments can be performed with an ultra-low frequency oscillator and a pen recorder oscillograph.
- This equipment also incorporates an automatic self-balancing recorder. The principle of recording servomechanisms can be simulated with this equipment. In addition, it can also serve as a recorder for recording the results of experiments performed with other equipment.
- An experiment guide book which contains procedures for various experiments is available on request.

TYPE MO-2, AUTOMATIC CONTROL TECHNIQUE TRAINER

APPLICATIONS

This equipment is provided for the following purposes.

(1) To allow students to obtain Bode's and Nichols' diagrams from measurements taken on a servomechanism system in order to acquaint themselves with procedures for operating and designing servomechanisms.

(2) To students to observe the effects of serial compensating circuits on servomechanisms in order to determine ways to improve the stability of servocontrol systems.

(3) To allow students to familiarize themselves with the operational theory of automatic self-balancing recorders.

TYPES OF EXPERIMENTS

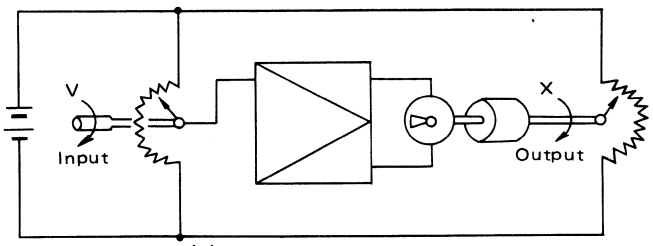
This equipment is mainly comprised of the servomechanisms shown in Fig. 1. By using three different circuits incorporated in the equipment, experiments can be performed to clarify the following.

1. The relationship between phase margin and gain margin.
2. The significance of gain adjustment, especially the relationship between phase margin and gain margin.
3. The improvement of servomechanism control characteristics by using compensating circuits.
   - 3.1 Techniques necessary for acquiring optimum control characteristics by adjusting amplifier gain and using phase lead and phase lag circuits.
   - 3.2 Most effective means for compensation required for optimum control in terms of stationary and transient responses.
4. Indicial response of the servomechanism operated in conjunction with an oscillator and a pen recorder oscillograph.
5. Operational theory and cautions of the automatic self-balancing recorders.

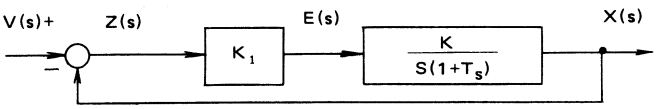
It is ideal that this equipment should be used in conjunction with an ultra-low frequency oscillator and a pen recorder oscillograph to perform quantitative experiments, but this equipment alone is capable of performing experiments to a certain extent.

GENERAL

Power requirements:	100V AC, 50/60 Hz.
Dimensions:	Approx. 450(H) x 500(W) x 280 (D) mm.
Accessories supplied:	3 rolls of recording paper (for the built-in self-balancing recorder).
Complementary equipment required:	Ultra-low frequency oscillator (Ando's type ULO-5 or equivalent) and 2-pen recorder oscillograph.

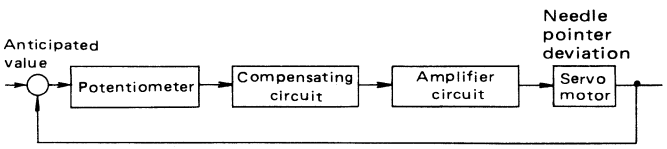


(a) Schematic diagram

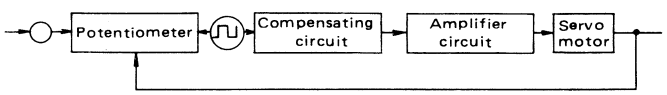


(b) Block diagram

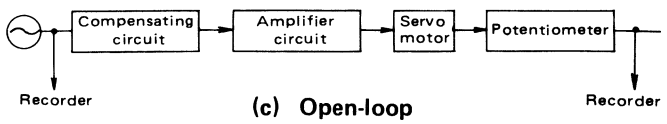
Fig. 1 Servomechanisms



(a) Servomechanism



(b) Closed-loop



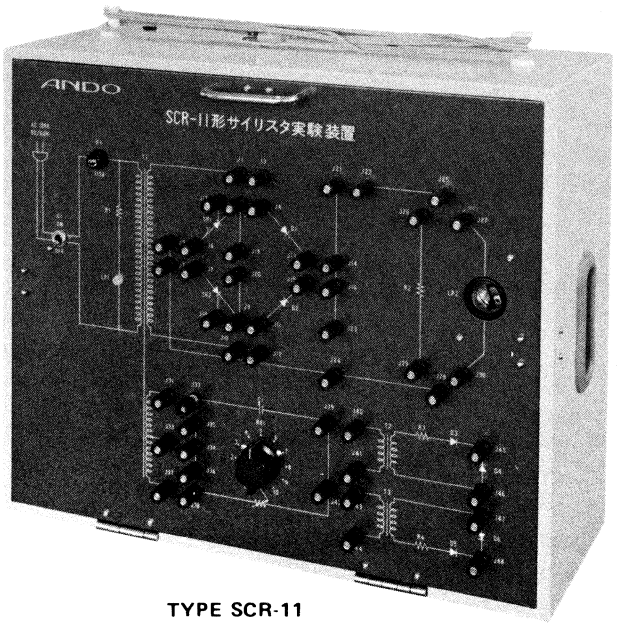
(c) Open-loop

Fig. 2 Typical circuits

THYRISTOR TRAINERS

TYPES SCR-11/12/13/14/15

- *Experiments from fundamental exercises to applied studies of thyristor circuits*



TYPE SCR-11

Ando's Thyristor Training System is divided into 5 grades from Type SCR-11 to -15 according to the contents of experiments from fundamental exercises to applied studies of thyristor circuits.

To study and understand the principles easily, and to apply the trainers perfectly, each of the 5 training models provides a graphical representation of the various typical circuits printed on the panel board.

The panel board can be opened to a slant of about a 30° angle for easy maintenence and observation of the inside.

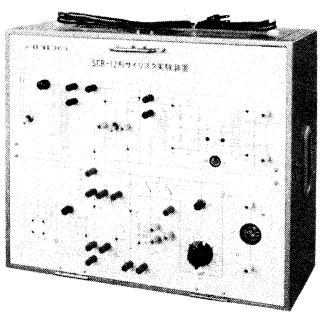
Type SCR-11 Thyristor Trainer:
For fundamental exercise (study of the operation principle of thyristor circuits)

Type SCR-12 Thyristor Trainer:
For non-contact switching exercise of DC and AC circuits

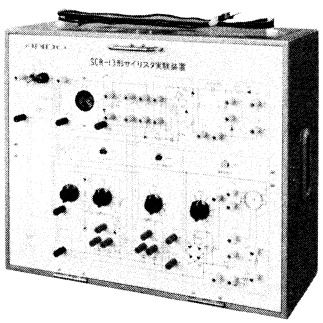
Type SCR-13 Thyristor Trainer:
For gate circuit exercise

Type SCR-14 Thyristor Trainer
For exercise of automatic voltage control for AC/DC dynamos

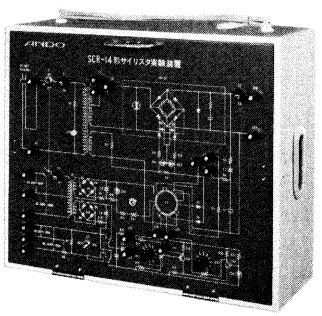
Type SCR-15 Thyristor Trainer:
For power inversion exercise (thyristor inverter exercise)



TYPE SCR-12



TYPE SCR-13



TYPE SCR-14

TYPES SCR-11/12/13/14/15, THYRISTOR TRAINERS

FEATURES AND TRAINING SCHEDULE

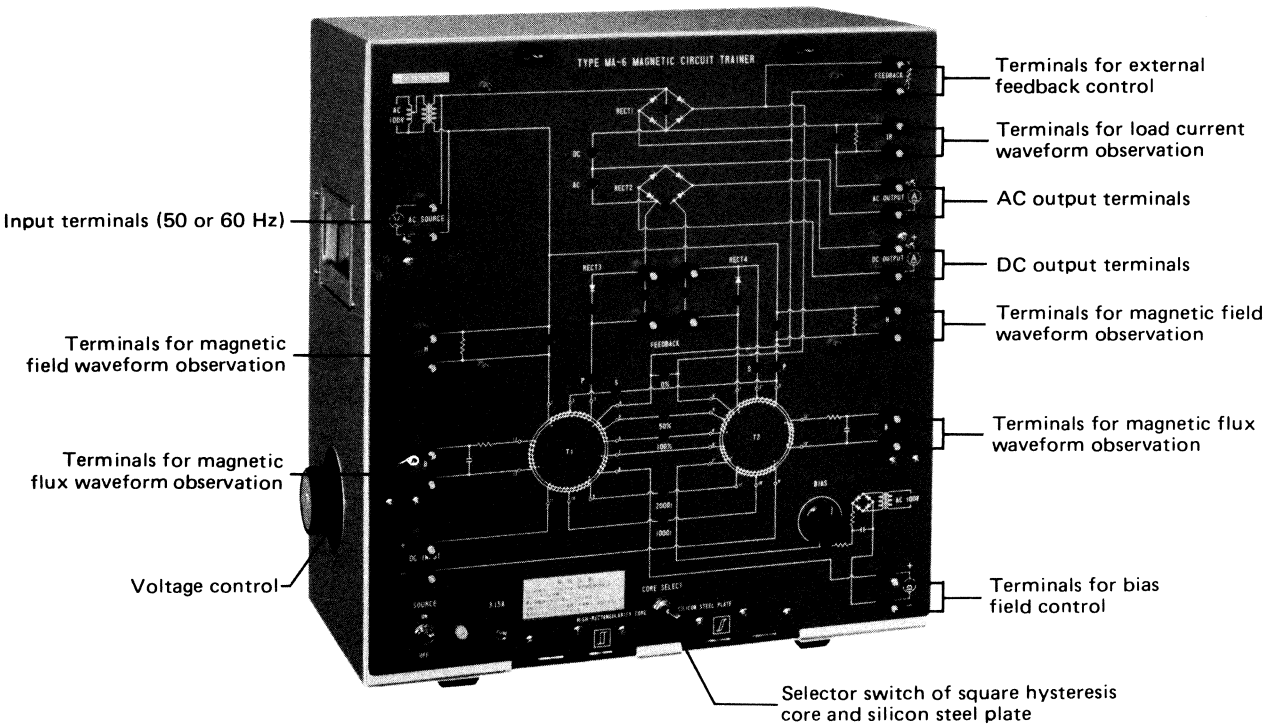
Type	Features	Training schedule
SCR-11	1. Circuits are easy to understand, and plug-in cables and U-links are used for ease of circuit change. 2. The pattern of thyristor function can be easily understood by experiments of phase control with single-phase half-wave rectification, single-phase full-wave rectification, and AC output. 3. The thyristor controlling polarity and state of phase control can be understood by experiments of phase control with Toulon circuit. 4. When the circuit output is applied to a lamp, the basic action of the thyristor can be visually understood.	1. Study of the principle of operation of the thyristor 2. Study of phase control and its method 3. Single-phase half-wave rectification 4. Single-phase full-wave rectification 5. Principle and application of AC control 6. Simulation of experimental data
SCR-12	1. Circuit changeover and formation are easy. 2. The thyristor can be compared with conventional electromagnetic switches. 3. Experiments can be performed in new fields where no switches other than the rapid contactless ones find application.	1. Switching of the DC circuit (methods and types) 2. Switching of the AC circuit (methods and types) 3. Study of the performance of the thyristor as a rapid contactless switch and the meaning of its sequence 4. Study of the use of the thyristor with a photoelectric switch 5. Comparison of the thyristor with conventional switches
SCR-13	1. Circuit changeover is made easy by plug-in cables. 2. As each circuit has a trimming control, the angle of thyristor conduction can be read from the control scale. 3. Parts are kept in the same case as those of other types and are so designed as to help to understand and test the circuits.	1. Study of phase control by magnetic saturation 2. Phase control with Toulon circuit 3. Phase control by R-C relaxation oscillation
SCR-14	1. The maximum output of the AVR is 400W. The SCR-14 can be used with any type of generator of a small to medium capacity and matches any field load, as the output of the AVR is variable. 2. The SCR-14 can be used with an AC or DC generator, and it operates at any voltage so long as it falls within the range of 80 to 220 V. 3. The experimental procedure is so designed that beginners can easily understand the theoretical and practical aspects of the feedback technique.	1. Study of excitation characteristics of generators 2. Experiments with the automatic voltage regulator and voltage amplifier 3. Function of the thyristor for an automatic voltage regulator 4. Study of the stability and instability of thyristor performance from the standpoint of automatic control engineering 5. Application of the thyristor to DC and AC generators
SCR-15	1. Circuit switching (between DC-AC conversion and AC-DC conversion) can be done at the flick of a switch. 2. The power supply of the inverter is 24V DC. Single-phase AC commercial power can be used for the charger. 3. Terminals for connection of an oscilloscope are provided for visual observation of the waveform in various tests.	1. Fundamental experiments with the thyristor inverter 2. Applications of the thyristor inverter 3. Battery charging with the thyristor 4. Observation of the waveform of operating signals

DIMENSIONS, WEIGHT AND POWER REQUIREMENTS

Type	Dimensions	Weight	Power requirements
SCR-11	Approx. 200H x 500W x 425D mm	Approx. 14kg	100 V AC, 50/60 Hz
SCR-12		Approx. 14kg	
SCR-13		Approx. 15kg	
SCR-14		Approx. 20kg	
SCR-15		Approx. 18kg	

MAGNETIC CIRCUIT TRAINER

TYPE MA-6



The MA-6 is a magnetic circuit trainer for educational purposes. If it is used in a classroom, students can concretely and easily understand the lecture about magnetic amplification.

The MA-6 is housed in a portable metal case and can be used in a vertical, horizontal or oblique position as called for by the experimental procedure. All the circuits are graphically reproduced on the front panel, and a desired circuit of magnetic amplification can be easily obtained by simple reinsertion of the plug.

FEATURES

- Switching from one circuit to the other can be easily accomplished by simple reinsertion of the plug. Circuits of self-feedback, external feedback, doubler, saturable reactor, and BH curve measurement can be formed by the use of accessory circuit guide plates.
- The MA-6 can be used to test the knowledge acquired about the circuitry. It shows whether students select a circuit of interest from the network of plural circuits shown on the front panel.
- The characteristics of an amplifier are greatly influenced by the BH curve of cores. A "50% Ni Permalloy" core is used in this instrument as representing the rectangular BH curve of cores, and its BH curve can be compared with that of a silicon steel plate.
- The hysteresis curve can be observed.
- The magnetism inside a core and the waveform of a load current can be observed. The waveform showing the relation between magnetic core saturation and load current can be observed on a CRT by using an oscilloscope.

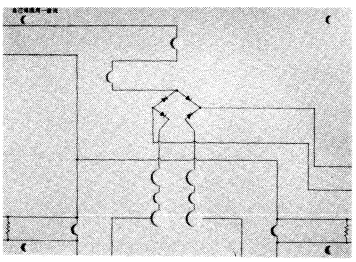
TYPE MA-6, MAGNETIC CIRCUIT TRAINER

TRAINING SCHEDULE

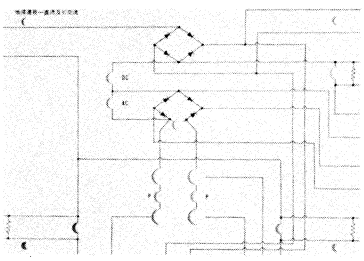
1. Experiments of the law of ampere-turn
2. Study of the relation between current gain and turn ratio
3. Comparison of gains of various feedback amplifiers
4. Study of the relation between amplifier gain and BH curve (Comparison of a square hysteresis core with a silicon steel plate)
5. BH curve observation
6. Observation of the waveform showing the relation between magnetic saturation and load current
7. Study of the influence of line voltage variations on amplification
8. Study of time constants
9. Experiments with typical magnetic amplification circuits

CIRCUIT GUIDE PLATES

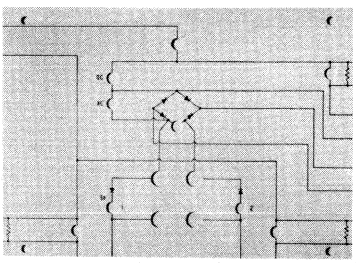
The following circuit guide plates with connecting instructions are supplied with the instrument.



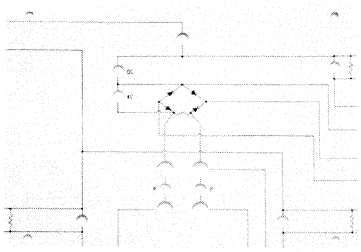
Self-feedback — DC



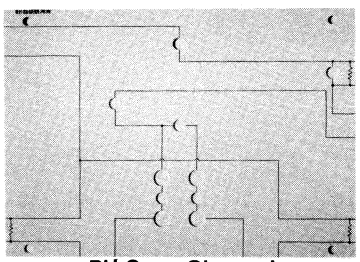
External-feedback — DC and AC



Self-feedback (doubler) — DC and AC



Saturable Reactor — DC and AC



BH Curve Observation

GENERAL

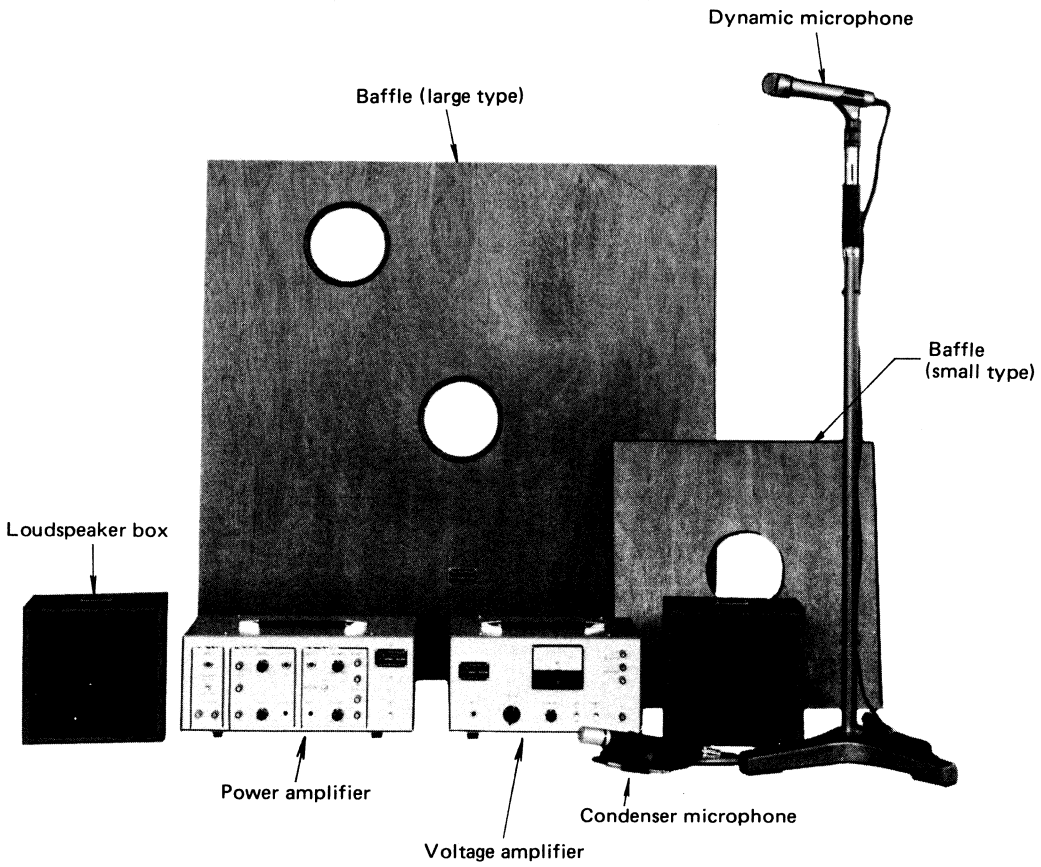
Power requirements:	100V AC, 50/60 Hz.
Dimensions:	Approx. 420(H) x 450(W) x 200(D) mm.
Weight:	Approx. 27 kg.
Accessories supplied:	
Circuit guide plate:	5
Plug:	15
Power cable:	1
Fuse:	1
Connecting cable:	20
Accessory case:	2
Experiment guide:	1

Complementary apparatus available:

DC ammeter:	10 and 100 mA	2
	500 mA	1
AC ammeter:	500 mA	1
AC voltmeter:	150 V	1
Slide rheostat:	0.2/0.4 A, approx. 10000/2500Ω	1
	0.4/0.8 A, approx. 2500/625Ω	3
Oscilloscope:	One dual trace or two single trace oscilloscopes	

ACOUSTIC TECHNIQUE TRAINER

TYPE ASA-13



The ASA-13 is an acoustic technique trainer which has been developed to help students obtain a better understanding of lectures on electroacoustics. (It does not need a special sound-proof chamber, if slight errors are allowed. If a measurement room is separated from a sound chamber, more effective experiments can be performed.)

FEATURES

- By the combined use of the F-V converter housed in a power amplifier and an XY recorder, frequency characteristics are semiautomatically recorded. The ASA-13 is especially easy to operate, and measurement can be completed in one-tenth of the time required by conventional instruments.
- As all necessary apparatus are included in the ASA-13, much time can be saved in the preparation.
- Additional interesting experiments can be performed in connection with acoustic apparatus.
- Various applied experiments can be performed by changing the combination of parts.

TRAINING SCHEDULE

1. Comparison of the construction and directivity between a dynamic microphone and a condenser microphone (Fig. 1)
2. Measurement of frequency characteristics of speakers (Fig. 2)
3. Study of the relation between the bandwidth of the reproduced frequency and the tone quality, tone color and articulation
4. Study of the effects of baffles and cabinets
5. Elucidation of the cause of the stereophonic effect

TYPE ASA-13, ACOUSTIC TECHNIQUE TRAINER

SPECIFICATIONS

Power Amplifier:
- Power amplifier: Frequency response, 60 Hz to 20 kHz; maximum output, 12W into 16Ω load.
- Phase shifter: Frequency, 200 Hz; phase variable range, approximately ±30°.
- F-V converter: Output, 0 to 10V (logarithmic to frequency); frequency range, 20 Hz to 2 kHz and 200 Hz to 20 kHz.
- Power requirements: 100V AC, 50/60 Hz.
- Dimensions: Approx. 150(H) x 350(W) x 200 (D) mm.
- Weight: Approx. 6 kg.

Voltage Amplifier:
- Amplification gain: More than 80 dB (the voltage amplifier can also serve as a 50 dB pre-amplifier).
- Amplification range: 0 to 25 dB in 5 dB steps.
- Scale graduations: -5 to +5 dB.
- Frequency response: Within ±3 dB, 100 Hz to 20 kHz.
- Power requirements: 100V AC, 50/60 Hz.
- Dimensions: Approx. 150(H) x 350(W) x 200(D) mm.
- Weight: Approx. 3 kg.

Condenser Microphone:
- Impedance: 600Ω (rating).
- Sensitivity: -71 dB (0 dB = 1V/μBar, 1000 Hz).
- Weight: Approx. 240 g.

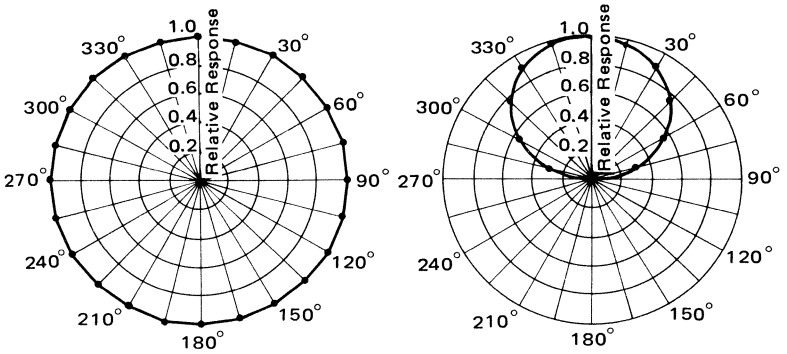
Dynamic Microphone:
- Impedance: 600Ω (rating).
- Sensitivity: -75 dB (0 dB = 1V/μBar, 1000 Hz).
- Weight: Approx. 240 g.

Dynamic Speaker:
- Min. resonant frequency: 70 to 85 Hz.
- Moving coil impedance: 16Ω (rating).
- Allowable input: 3W max.
- Output sound level: 96 dB/W or more.
- Outer diameter: 165 mm.
- Dimensions: Approx. 210(H) x 210(W) x 125(D) mm.
- Weight: Approx. 1 kg.

Microphone Stand:
- Height (unfolded): 902 to 1514 mm.
- Weight: Approx. 3.5 kg.

Baffle (large type):
- Dimensions: Approx. 900(H) x 900(W) x 50(D) mm.
- Weight: Approx. 6 kg.

Baffle (small type):
- Dimensions: Approx. 450(H) x 450(W) x 15(D) mm.
- Weight: Approx. 2 kg.



(A) Dynamic microphone (B) Condenser microphone

Figure 1. Directivity of microphones

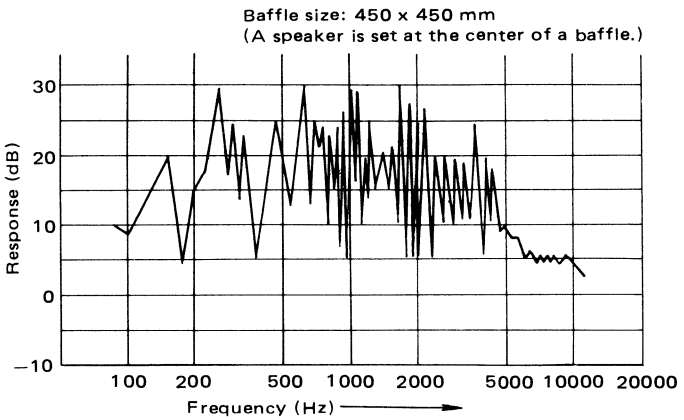
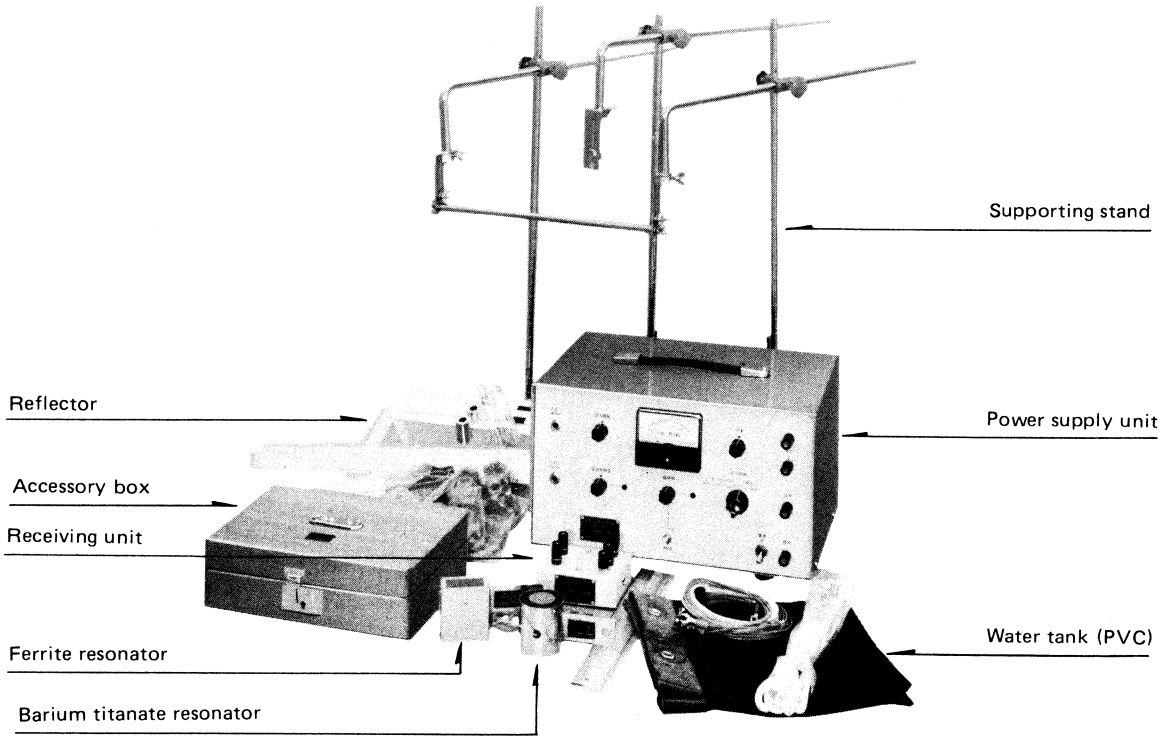


Figure 2. Sound Pressure/frequency Characteristic Curve

Complementary equipment available
1. Continuously variable oscillator (Ando's Type TCO-48 Oscillator is recommended)
2. Variable filter (Ando's Type VF-16 Filter Circuit Trainer is recommended)
3. X-Y recorder
4. Resistance standard

SUPERSONIC WAVE TECHNIQUE TRAINER
TYPE UST-1

● *For fundamental experiments on supersonic wave techniques*



In recent years the supersonic wave instruments have been used in various fields including food manufacture, dish washing, and medicine and have been acquiring increasing importance in our daily life. The increasing use of supersonic wave instruments is explained by the special nature of the supersonic wave. However, the supersonic wave technology cannot possibly be used to best advantage, unless the supersonic wave itself is studied to the full extent. The familiarity with the operating procedure of the supersonic wave instruments is not enough. The UST-1 is a supersonic wave technique trainer which has been developed for educational purposes and is instrumental in the clarification of various phenomena of the supersonic wave in water and in the collection of technical information on the supersonic wave.

FEATURES

- Various fundamental experiments can easily performed by changing the combination of the experimental components.
- The characteristics of the electroacoustic transducer can be studied in connection with its construction.
- The power supply section can be used as a power amplifier for general purposes. As AM terminals are provided, the power supply section finds use in many applications.

TYPE UST-1, SUPERSONIC WAVE TECHNIQUE TRAINER

TRAINING SCHEDULE

1. Vibrator impedance measurement
2. Experiment of supersonic wave directivity
3. Experiment of supersonic wave reflection characteristics
4. Study of the relation between wavelength and sound velocity
5. Supersonic cleaning experiment
6. Supersonic heating experiment
7. Supersonic emulsification experiment
8. Experiment of sound detection in water
9. Supersonic communication experiment

NOTES

1. For the experiments 2, 3, 8 and 9 above, a water tank large enough not to give rise to the reflected wave is necessary, and provision must also be made to avoid ripples. The experiments 1, 4, 5, 6 and 7 can be performed with the PVC tank supplied with the instrument.
2. For the experiment 9, the Type ASA-13 Acoustic Technique Trainer is required as a companion instrument.

COMPOSITION

Description		Quantity	Remarks
Power supply unit		1	
Receiving unit		1	
Resonator		2	Approx. 50 kHz
Supporting bar		3	
Supporting stand		3	
Reflector		3	
Water tank (with rope)		1	PVC (1000x400x250 mm) for experiments 1, 4, 5, 6 & 7
Accessory kit	Accessory box	1	
	Test tube	2	
	Scale	1	
	Fuse	3	
	Lamp	1	
	Connection cable	8	

EXPERIMENT EXAMPLES

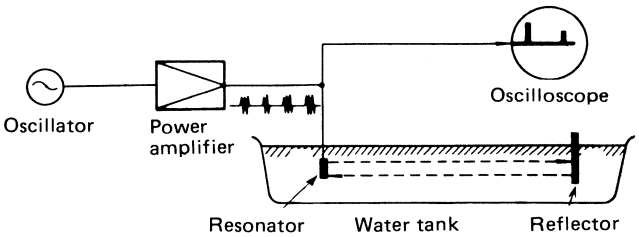


Fig. 1 Sound Detection in Water by Supersonic Pulse

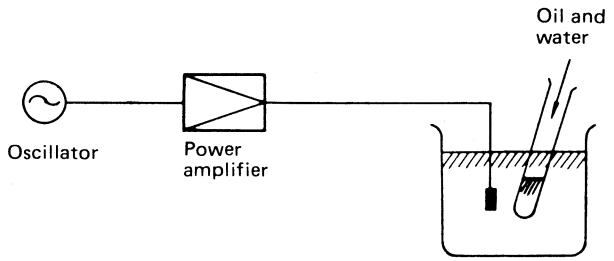


Fig. 2 Experiments of Emulsification and Corpuscle Cohesion

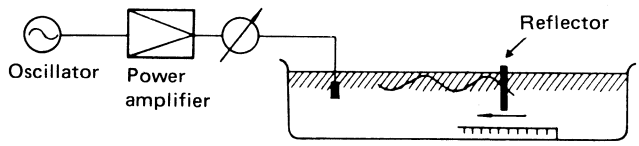
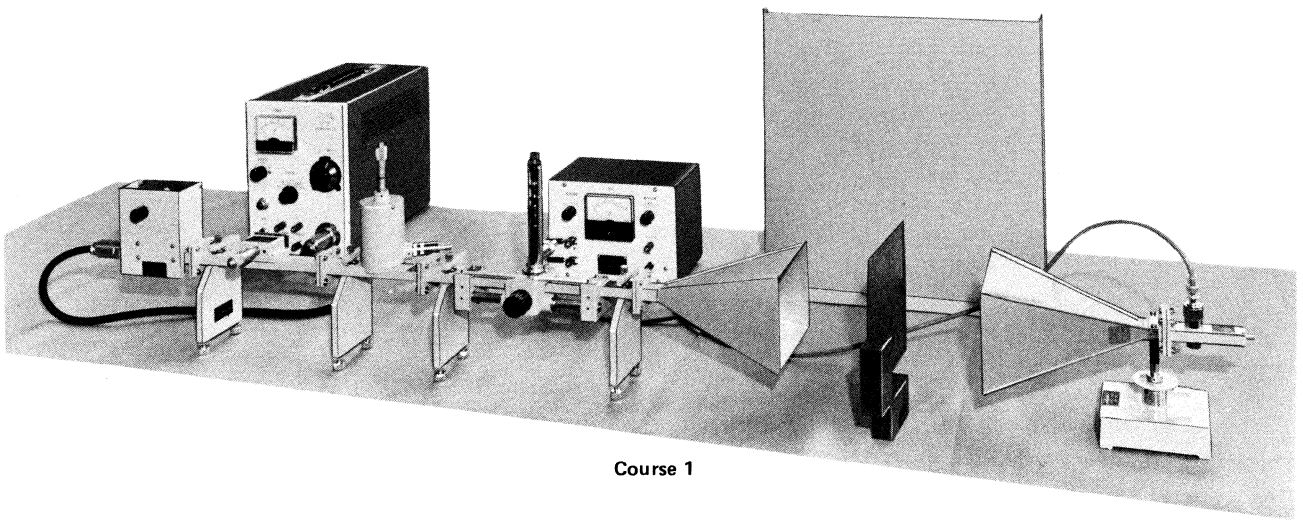


Fig. 3 Measurement of Sound Velocity in Water

APPARATUS AVAILABLE

Sine wave oscillator (10 to 100 kHz):
1 (Ando's Type TCO-48 Oscillator is recommended).
Dual trace oscillascope: 1
Voltage amplifier:
1 (Ando's Type TLM-35B Level Meter is recommended)
Acoustic technique trainer:
1 (Ando's Type ASA-13 is recommended)

MICROWAVE TECHNIQUE TRAINERS



Course 1

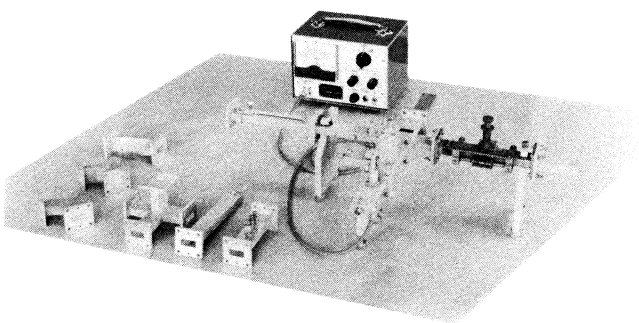
The recent trend in communications is toward the use of shorter waves, and microwaves which are extremely short in length as the name suggests are now used extensively. Ando's microwave technique trainer is designed to allow students to have a quick and sound understanding of the fundamentals of microwave techniques through experimentation.
The microwave technique trainer is divided into four courses from course 1 to 4 according to the exercises performed.

TRAINING SCHEDULE

Course 1: Elementary experiments
Course 2: Advanced experiments (the instruments of course 1 are also required in addition to those of course 2)
Course 3: Experiments on simplified voice communications (the instruments of course 1 are also required in addition to those of course 3)
Course 4: Complicated circuit experiments (the instruments of course 1 or courses 1 and 2 are also required in addition to those of course 4)

FEATURES

- A wide variety of experiments can be performed.
- The theory and uses of the oscillation mode of the klystron and Q-curve of a cavity frequency meter can be easily understood by experiments.
- Circuit protection is given to the instruments against possible damage due to inadvertent operation.
- The microwave technique trainers have been developed in accordance with the Standards of Electronics Industries Association of Japan so that they can be used not only for educational purposes but also for general tests and measurements.



The combination of courses 2 and 4

MICROWAVE TECHNIQUE TRAINERS

LIST OF EXPERIMENTS

	Exercises of each course	Course 1	Course 2	Course 3	Course 4
1	Handling of a klystron and a klystron power source, and learning the principle of oscillation by the use of a klystron	○			
2	Experiment on the klystron oscillation mode and visual observation of the klystron oscillation mode by the use of an oscilloscope	◎			
3	Detection of microwaves by the use of a crystal mount	○			
4	Impedance measurement by the use of standing wave ratio, and learning of Smith-chart	○	△		
5	Measurement of guide wave length and frequency by the use of standing waves	○			
6	Frequency measurement by transmission and reflection methods, and learning of a cavity resonator	◎			
7	Observation and measurement of Q of a cavity resonator by the use of an oscilloscope	◎			
8	Experimenting and learning of the principle of a variable attenuator	○	△		
9	Precise measurement of attenuation of a waveguide circuit	○	△		
10	Measurement of directivity and gain of an electromagnetic horn	○			
11	Understanding of attenuation of microwave in space propagation, reflection by an object and deflection by a screen	○		△	
12	Exercise of power measurement by the use of a thermistor mount and a thermistor bridge		○		
13	Measurement of residual standing wave ratio of a standing wave detector		○		
14	Making and measurement of desired load impedance by the use of a variable attenuator and a variable short end		○		
15	Making of reflected waves, and impedance matching		○		△
16	Measurement of the degree of coupling and direction of a directional coupler, and experiment of power measurement by the use of a directional coupler		○		
17	Experiment of simplified microwave voice communications with AM			○	
18	Experiment of simplified microwave voice communications with FM			○	
19	Learning of the principle of a magic T and measurement of various characteristics				○
20	Measurement of reflected power by the use of a magic T and other experiments				○
21	Experiments above in complicated circuits				○

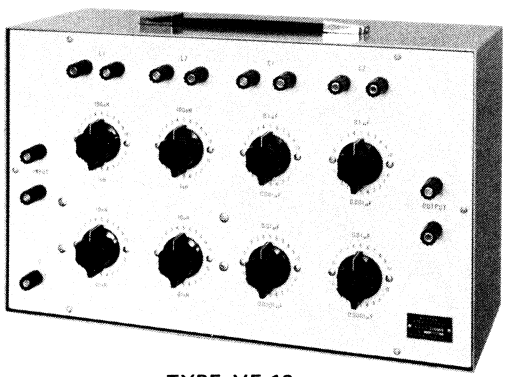
Notes
○: Typical experiments of each course
◎: Experiments proper to Ando's microwave technique trainer
△: More precise and sophisticated experiments can be performed in the corresponding course.

FILTER CIRCUIT TRAINERS

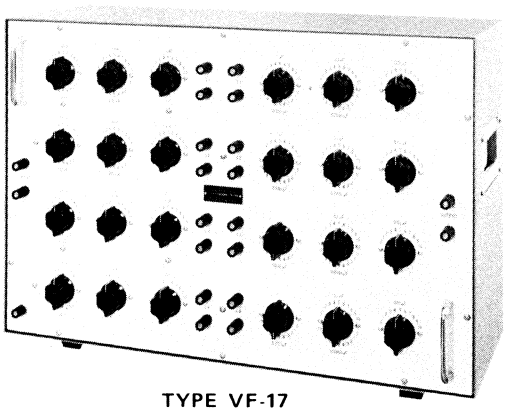
TYPES VF-15/16/17

- *Can form a low-pass filter, high-pass filter, band-pass filter and band-rejection filter*

TYPE VF-15



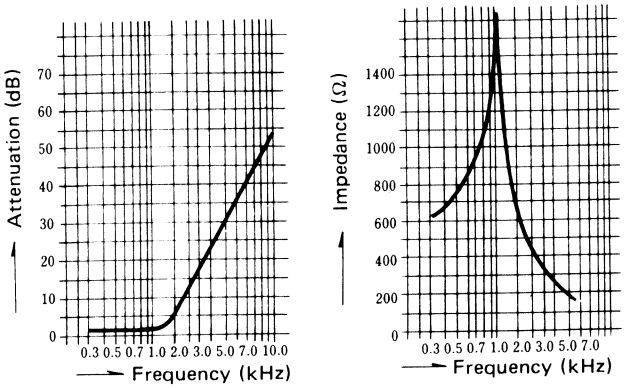
TYPE VF-16



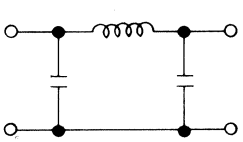
TYPE VF-17

- The series of filter circuit trainers can form various filters such as a low-pass filter, high-pass filter, band-pass filter, and band-rejection filter.
- They can also be used as a variable self-inductor or a variable capacitor.
- A resonant circuit in a series or a parallel arrangement can be formed with this series of filter circuit trainers as desired so that they can also be used in experiments of the resonant circuit.

EXAMPLE OF CHARACTERISTICS
(Type VF-16: One section of constant K type)



Attenuation characteristics　　Impedance characteristics



Example of circuit composition

TYPES VF-15/16/17, FILTER CIRCUIT TRAINERS

SPECIFICATIONS

Type		VF-15	VF-16	VF-17
Inductance elements		5 sets of an inductance determined by the cut-off frequency	2 sets for 0.1 to 1100mH	2 sets for 0.1 to 1110mH 2 sets for 0.01 to 1110mH
Capacitance elements		5 sets of a capacitance determined by the cut-off frequency	2 sets for 0.0001 to 1.1μF	2 sets for 0.0001 to 1.11μF 2 sets for 0.0001 to 11.1μF
Circuit (external connections are made between terminals.)		Refer to Fig. 1	Refer to Fig. 2	Refer to Fig. 3
Filters obtained with the VF-15, VF-16, and VF-17	Characteristic impedance	600Ω unbalanced	600Ω unbalanced	600Ω unbalanced
	Cut-off frequency (low-pass and high-pass filters)	500, 1000 or 2000 Hz	Any frequency in the neighborhood of 1000 Hz	Any frequency in the neighborhood of 1000 Hz
	Center frequency (band-pass and band rejection filters)	1000 Hz	Any frequency in the neighborhood of 1000 Hz	Any frequency in the neighborhood of 1000 Hz
Dimensions (H x W x D)		Approx. 270x490x235mm	Approx. 250x400x200mm	Approx. 400x600x200mm
Weight		Approx. 15 kg	Approx. 8 kg	Approx. 18 kg

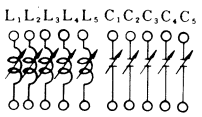


Fig. 1

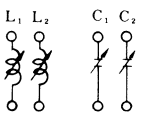


Fig. 2

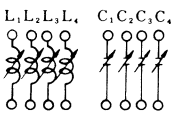


Fig. 3

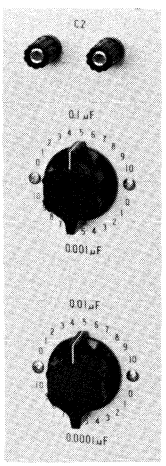
EXAMPLES OF LOW-PASS FILTER CIRCUITS

The circuits of low-pass filters obtained with the VF-15, VF-16, and VF-17 are shown below by way of example. The circuits of high-pass, band-pass, and band-rejection filters can also be formed in a similar way.

VF-15	VF-16	VF-17
Formula $L_2=L_3=L_4=\frac{2R}{\omega}$ $C_1=C_4=\frac{1}{R\omega}$ $C_2=C_3=\frac{2}{R\omega}$		
$L_1=L_5=\frac{1-m^2}{m}\cdot\frac{R\omega}{\omega}$ $L_2=L_4=(1+m)\frac{R}{\omega}$ $L_3=\frac{2R}{\omega}$ $C_1=C_5=\frac{m}{R\omega}$ $C_2=C_3=\frac{2}{R\omega}$		
$L_2=L_4=\frac{mR}{\omega}$ $L_3=\frac{2R}{\omega}$ $C_1=C_5=\frac{1-m^2}{m}\cdot\frac{1}{R\omega}$ $C_3=C_4=(1+m)\frac{1}{R\omega}$		

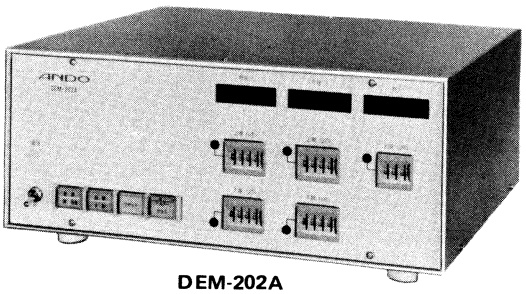
SERVICEABLE DIALS FOR USER CONVENIENCE

The filter circuit trainers are so designed that two decades can be varied with one dial. Therefore, parameters of two or three significant digits can be set, when two (VF-16) or three (VF-17) dials are used together. On the right is shown the combination of two dials in the VF-16 with which any parameter of two digits from 0.0001μF to 1.1μF can be set.

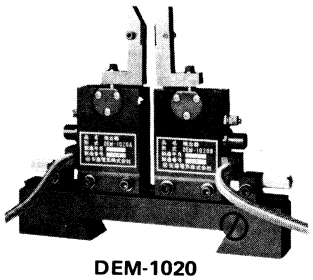


ELECTRONIC MICROMETERS

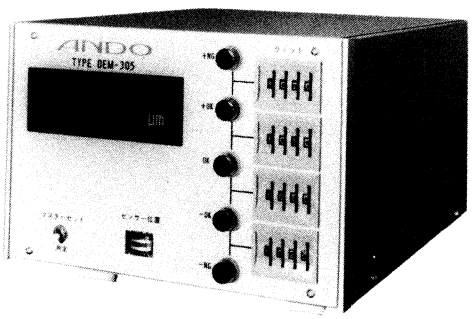
TYPES DEM-200/300/600



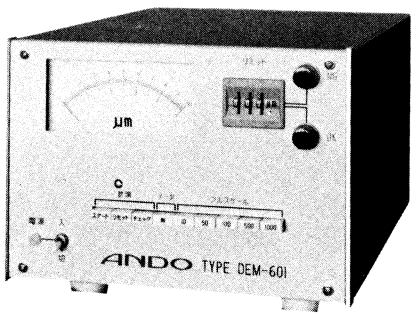
DEM-202A



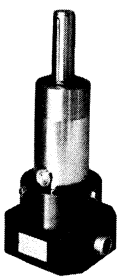
DEM-1020



DEM-305



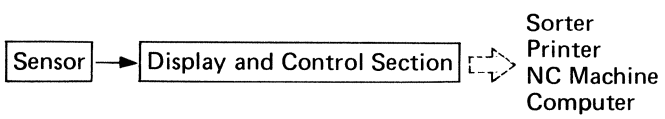
DEM-601



DEM-2031

The DEM-200 and -300 series of Ando's electronic micrometers electrically measure minute deviations in dimensions of mechanical and electric parts, and indicate the measurements on the digital display or meter. When they are combined with other equipment, integrated automatic measuring systems can be formed; such integrated measuring systems not only make and indicate measurements but also make a decision, sort, and transport finished parts.
The DEM-600 series is specially designed for use in the measurement of deviations of such dimensions as inner and outer diameters.

Electronic Micrometer Composition



FEATURES

- Instrument performance is little affected by environmental conditions, and high accuracy on the order of microns can be achieved.
- The DEM-200 and -300 series perform calculations, indicate measurements, and determine tolerance settings in digital notation, contributing a great deal to the achievement of high speed and high accuracy. The DEM-600 series are low-cost, general-purpose instruments with a number of uses that can be easily operated even by an unskilled operator.
- As master values can be entered at the mere touch of a control, anyone can easily operate these electronic micrometers.
- The system capacity can be expanded by adding a necessary number of units, when simultaneous measurements at many points are desired. Inspection and automatic sorting of complicated works can be carried out at low cost.
- The tolerances for rejection and grading can be digitally set on the instrument.
- ICs are used throughout the circuitry so that high reliability of performance is achieved.

TYPES DEM-200/300/600, ELECTRONIC MICROMETERS

SPECIFICATIONS, DISPLAY AND CONTROL SECTION

Instruments	DEM-200 Series	DEM-300 Series	DEM-600 Series
Use	Multi-point measurement	Single-point measurement	Single-point measurement
Type of display	Digital		Analog
Measurement range	0 to 999 μm	0 to 999 μm or 0 to 99.9 μm	0 to 1 mm
Accuracy	Within ± (0.5% + 1 count) of reading		Within ±1.5% of reading
Limit settability	Digital setting of upper and lower limits		
	00.0 to ±99.9 μm (in 0.1 μm step) 000 to ±999 μm (in 1 μm steps)		000 to ±999 μm (in 1 μm steps)
Zero setting	Single-touch setting in electronic memory		Automatic zero setting at initial position
Points of measurement	Individual A and B, A+B, A-B		
Operating temperature	0 to 40°C		
Power requirements	100V AC, 50/60 Hz		
Dimensions	Approx. 180x440x380 mm	Approx. 180x250x345 mm	Approx. 170x250x330 mm
Weight	Approx. 15 kg	Approx. 10 kg	Approx. 10 kg
Others		3 to 5 classifications	Peak-hold type 2 classifications

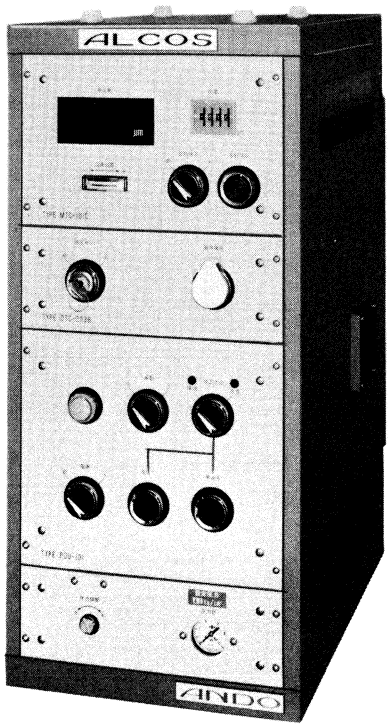
SPECIFICATIONS, SENSORS

Instruments	DEM-1011 Plunger-type sensor	DEM-1030 Plunger-type sensor	DEM-1020 Lever-type sensor
Use	Measurements of height and length		Measurements of outer diameter and deviations
Ponits of measurement	1		1 or 2
Measurement method	Single		Single or electric arithmetic operation
Stroke	3 mm	13 mm	10 mm
Straight line range	±700 μm	±6.5 mm	±700 μm
Measurement range	No limitation		0 to 140 mmϕ
Measuring weight	60 g (standard)	250 g (standard)	400 g (standard)
Contactor	Ultra-hard alloy		

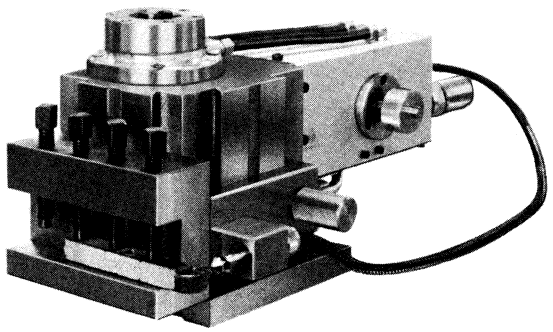
Instruments	DEM-2030 Inner Diameter Sensor	DEM-204 [ ] Inner Diameter Sensor
Points of measurement	1	1 (X, or X and Y directions)
Measurement method	Electronic arithmetic operation	
Stroke	±0.5 mm (at max.)	
Straight line range	±700 μm	
Measurement range	15 to 35 mmϕ*	20 to 60 mmϕ*
Measuring weight	60 g (standard)	
Contactor	Ultra-hard alloy	
Others	Floating type	

* Range is covered by replacing measurement guides and contactors.

ALCOS SERIES AUTOMATIC TOOL POSITION COMPENSATING SYSTEM



MTC-202 Control Equipment



APT-501 Tool Rest

The ALCOS Series Automatic Tool Position Compensating System fully employs Ando's advanced measurement techniques and precision machine technology. The system consists of a control equipment (MTC series, two models available) and a tool rest (APT series, two models available). It boasts of high performance/cost ratio and highly accurate tool positioning.

FEATURES

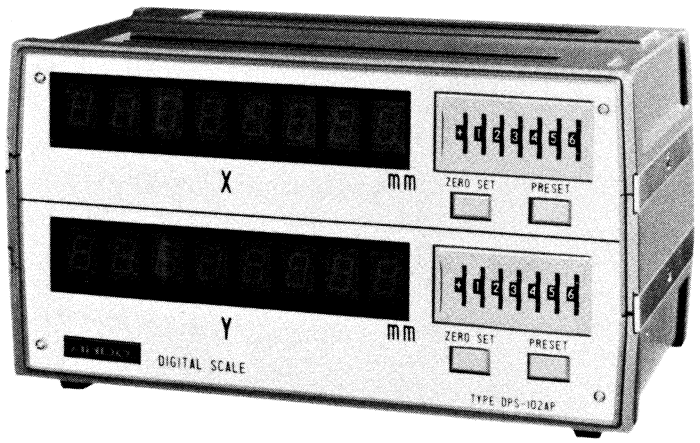
- High performance/cost ratio
- The amount of correction is variable in 1 μm steps, and values ranging up to ±999 μm can be set digitally.
- Simple to operate. When the depth of cut is set and the pushbutton switch is pressed, accurate tool positioning is automatically accomplished.
- The ALCOS system can be fitted to a single-purpose machine, such as a copying lathe.
- As the tool rest position is monitored by the closed loop control method at all times, errors due to backlash do not occur.
- All operations including sequence control are performed by solid-state semiconductor circuits so that high reliability of performance is achieved.

SPECIFICATIONS

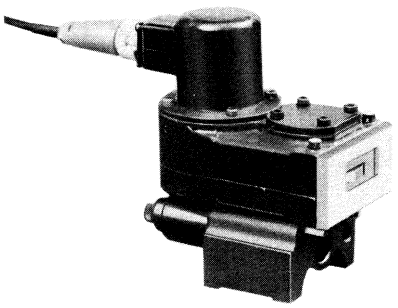
Method of compensation:	Presetting of a fixed depth of cut
Resetting:	Initial position restoration by pushbutton
Correction control:	Closed loop control method
Direction of correction:	Forward and reverse
Maximum amount of correction:	000 to 999 μm
Minimum correction step:	1 μm
Matching tool rest:	APT-101A and -301A
Power requirements:	100 V AC ±10%, 50/60 Hz
Power consumption:	Approx. 150 VA
Compressed air requirements:	4.5 to 9 kg/cm^2 (MTC-201A)
Operating temperature:	0 to +40°C
Dimensions:	Approx. 192(H)x400(W)x 385(D) mm
Weight:	Approx. 17 kg (MTC-201A)

DIGITAL SCALES

TYPES DPS-101A/101AP/102A/102AP



DPS-102AP



FRS-2010

The digital scale is a digital position indicator component that is designed to save labor in machine tool and other industrial machine operations. The digital scales of this series are designed so that they fit all sorts of machine tools and other industrial machines to cover virtually any application.

FEATURES

- As a roller type displacement sensor is employed, there is no limitation on the measurement length.
- All that is required to do when installing the digital scale is just bring its sensor into contact with the table. There is little restraint on installation.
- The standard models of these digital scales incorporate a cumulative error compensation circuit. As the error can be corrected by switch operation, subtle adjustment of the machine after installation or inspection is not necessary.
- These digital scales can be easily attached to machines in use.
- The large display permits easy reading.
- These digital scales are quite simple to operate. Novices can easily acquire the technique to operate them.
- These digital scales permit not only presetting and zero setting on the front panel but also external presetting and zero setting.
- The digital scales have many control inputs, such as preset data input, data output, data hold input, and data disable input, and can easily be connected to NC machines and external circuits. They can therefore cover virtually any application.

SPECIFICATIONS

Unit of indication:	0.005 mm
Indication range:	0 to 9999.99 mm
Indication:	±, mm, 7-digit number, and overflow
Reset function:	Zero setting (manual and automatic) can be done at any point on the scale.
Power requirements:	100 V AC, 50/60 Hz
Operating temperature:	0 to 40°C
Dimensions:	Approx. 151 x 281 x 154 mm
Sensor:	Rotary encoder (1000P/R)

Additional Functions

DPS-101A/DPS-102A
Data output

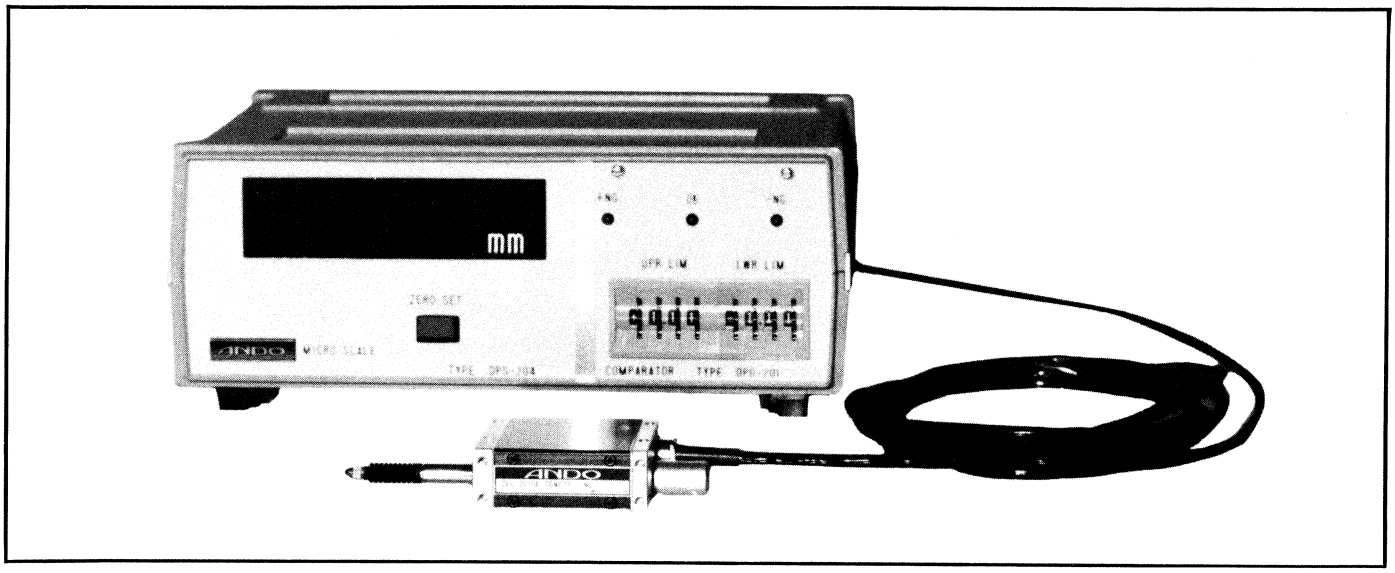
DPS-101AP/DPS-102AP
Data output, preset data input, digital switch, press switch

Sensor

FRS-2010 Sensor

Use:	Measurement of the distance of linear movement
Measurement method:	Reference roller contact method
Measurement unit:	5 μm (standard)
Rolling accuracy:	Within ±(5 + 0.01L) μm L = mm
Response speed:	12 m/min

MICROSCALE



This is a accurate and stable digital microscale that employs the linear glass encoder detection method. This microscale consists of DPS-204 Digital Display, DEG-2010A Sensor and DPO-201 Comparator (option).

FEATURES

- As this microscale digitally indicates dimensions (or displacement) as well as polarity, it saves the users the trouble of reading the dial and enables them to make accurate measurements in an efficient way. Even an unskilled person can make as accurate measurements as a skilled operator.
- Zero setting can be done at the mere touch of the pushbutton switch at any point of the scale.
- The upper and lower limit setting capabilities (option) can be provided.
- As a decision signal can be derived from the relay contact, this microscale can perform the function of an automatic tester when incorporated in the machine tool or other industrial machine.

SPECIFICATIONS

DPS-204 Digital Display

Mode of measurement:	Automatic continuous measurement
Indication:	4-digit number, ±, overflow
Indication range:	0 to ±9.995 mm in 0.005 mm steps Zero setting can be done at any point at the mere touch of the pushbutton
Data output:	3-digit BCD, serial, digit designation, polarity
Operating temperature:	0 to 40°C
Power requirements:	100/200 V AC, 50/60 Hz, approx. 7 VA
Dimensions and weight:	Approx. 101x281x154 mm, approx. 2.5 kg

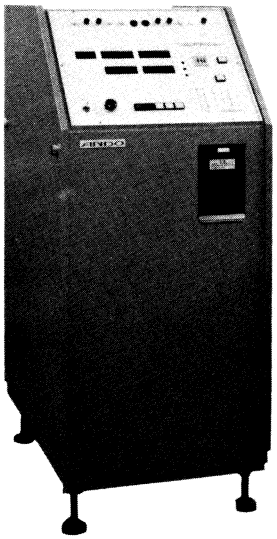
DEG-2010A Scale Sensor

Measurement range:	10 mm
Cumulative accuracy:	Within 5 μm (at 20°C)
Measuring weight:	Approx. 150 g
Response speed:	0.2 m/s max.
Connecting cable length:	3 m
Dimensions and weight:	Approx. 136x24x48 mm, approx. 400 g

DPO-201 Comparator (option)

Data input:	3-digit BCD, serial, digit designation, polarity
Limit setting range:	±0.00 to ±9.99 mm in 0.01 mm steps
Classifications:	3 classifications (+NG, OK, -NG)
Decision output:	+NG,-NG relay contact outputs; contact capacity: 220V AC, 0.8 A, cosϕ = 0.3
Decision output holding:	Decision output can be held by the external control input (relay contact signal).
Operating temperature:	0 to 40°C
Power requirements:	+5V (approx. 5 VA), supplied from the display.
Dimensions and weight:	Approx. 101x120x125 mm, approx. 0.8 kg

TAPELESS NC SYSTEM
TYPE ALNUC-12



The ALNUC-12 is a teach-in, playback-type NC system that uses no program tape. It accomplishes positioning through simultaneous control of the X and Y axes. This is a universal type NC system that fits all kinds of machine tools. When input data are entered into the built-in memory by an operator or a program is entered through the keyboard, this system enables the machine tool to accomplish automatic positioning and machining with high accuracy. The information stored in the memory can be dumped to magnetic tape (or cassette tape).

USES

Automation of punching press, drilling machine, tapping machine, and milling machine operation, automation of spot welding, automatic feed of electronic parts and mechanical parts, automation of straight cutting and machining, industrial robot position control, etc.

FEATURES

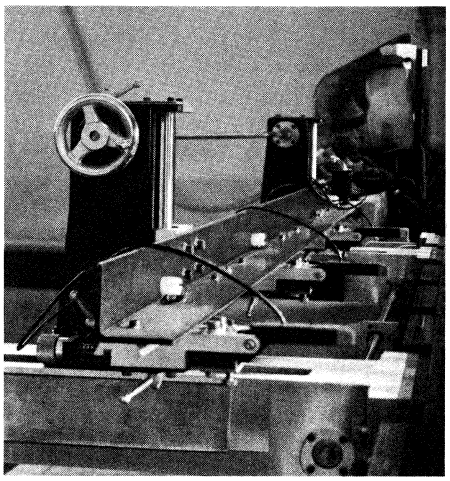
- As this system uses no punched tape, its running cost is low, and yet high reliability of performance is insured.
- This system can be easily fitted to any machine tool in use. The efficiency of the manual type machine tool can be increased by about 3 times with the aid of the ALNUC-12. Its cost is less than half that of the comparable NC machine tool, however. This system is especially suitable for job lot production of different types of products.
- This system is quite simple to operate; memory correction and manual operation can be done at the mere touch of the controls and the operators need not be specially trained.

SPECIFICATIONS

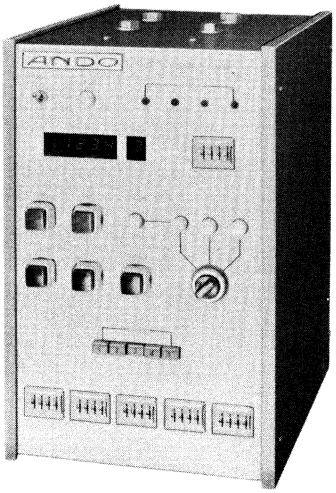
Axis control:	Simultaneous control of X and Y axes (Z axis control is also possible.)
Data input method:	Template or other scribing tool copying (or keyboard — option)
Instruction method:	Absolute
Indication:	X and Y command values, 4- and 5-digit present values, and 3-digit sequence numbers
Positioning accuracy:	Within 0.1 mm (or 0.01 mm)
Memory device:	Core memory (or IC memory)
Memory capacity:	200 points (can be expanded to 600 points)
	One-digit BCD can be output.
Fast feed:	10 m/min
Power requirements:	100 V AC, 50/60 Hz
Options:	Data input keyboard, magnetic card reader-writer, sequence setting unit

Scope of Supply
(1) Tapeless NC system mainframe plus control motor
(2) Mounting the system to the copying punching press and adjustment

AUTOMATIC POSITIONING CONTROL SYSTEM
TYPE ALNUC-20



Upward/Downward Adjuster



Control Section

The ALNUC-20 is a universal NC system that permits automatic uniaxial positioning in 5 or 10 steps in layout work through use of digital switches.
The bending or cutting dimensions are entered in order of machine tool operation, and the system is started in the proper operation mode. With this, the reference plane against which the backgauge butts and the work clamping carriage are automatically set to their proper positions, and highly efficient machining is carried on with high accuracy of repetition.

USES

Automation of press brake positioning

FEATURES

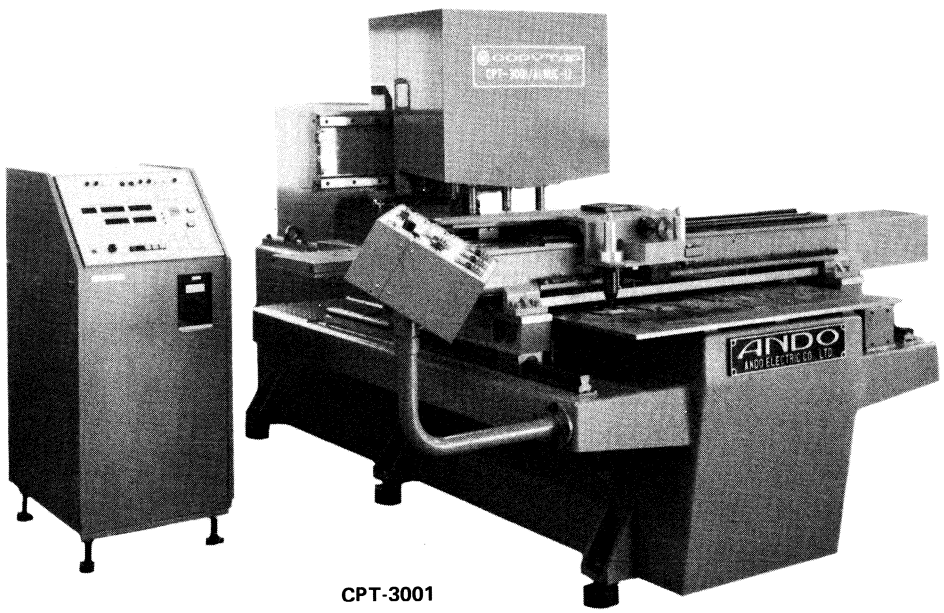
- The ALNUC-20, being a closed-type NC system that differs from the electrically driven backgauge, insures very high accuracy of repetition.
- The ALNUC-20 can be easily fitted to the machine tool in use.
- Very simple to operate, so that anyone can operate it.
- Cycle operation (repetition), automatic operation (one cycle only) or manual operation can be selected.
- Operational efficiency is 2.5 to 3 times as high as that of manual operation.

SPECIFICATIONS

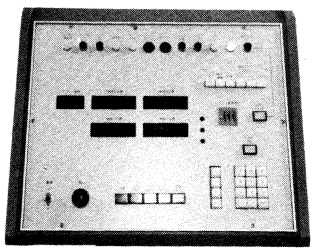
Settable steps:	5 (standard) and 10
Setting range:	0 to 500.0 mm (standard) 0 to 750.0 mm (in the case of the press brake)
Positioning accuracy:	±0.1 mm
Fast feed:	Approx. 5 m/min
Position:	4-digit indication
Operation modes:	Cycle operation : The cycle of a selected number of steps repeats itself. Automatic operation : Positioning for a selected step is automatically accomplished. Manual operation : Positioning can be done manually by pushbutton operation regardless of the settings.
Power requirements:	Control circuit: 100 V AC, 50/60 Hz Drive circuit: 200 V AC, 50/60 Hz
Options:	Control section carrier (in the standard ALNUC-20 system, the control section is of pendant type.)

Scope of Supply
(1) Automatic positioning control system mainframe plus control motor
(2) NC machine including the mechanical drive
(3) Mounting the system to the press brake and adjustment

AUTOMATIC TAPPING MACHINE
CPT-3000 SERIES



CPT-3001



Control Section Panel

Ando's automatic tapping machine of the CPT-3000 series consists of an ALNUC numerical control system and 3-axis tapping machine with an X-Y carriage. Programming is done by the direct input method; position instructions are entered by the teach-in method and tap axis instructions are keyed in.

FEATURES

- Teach-in playback NC system
- Program tape is not necessary.
- Automatic change of the tapping shaft
- Free screw pitch setting
- High economic efficiency
- Damaged tap detection capability (option)
- Program storage by the magnetic card reader-writer (option)

SPECIFICATIONS

Mechanical Section

Machining range:	990 x 650 mm
Positioning accuracy:	±0.1 mm
Number of tapping shafts:	3
Tap hole sizes:	M2.3 to M6
Material thickness range:	1 to 4.5 mm
Hit rate*:	20 holes/min
Feed:	15 m/min
Power requirements:	100/200 V AC, 50/60 Hz
Compressed air:	4 kg/cm^2
Dimensions:	Approx. 1800x3000x2200 mm
Weight:	Approx. 2000 kg

* When tapping for M3 holes at 25 mm pitch using steel sheet 2 mm thick.

Control Section

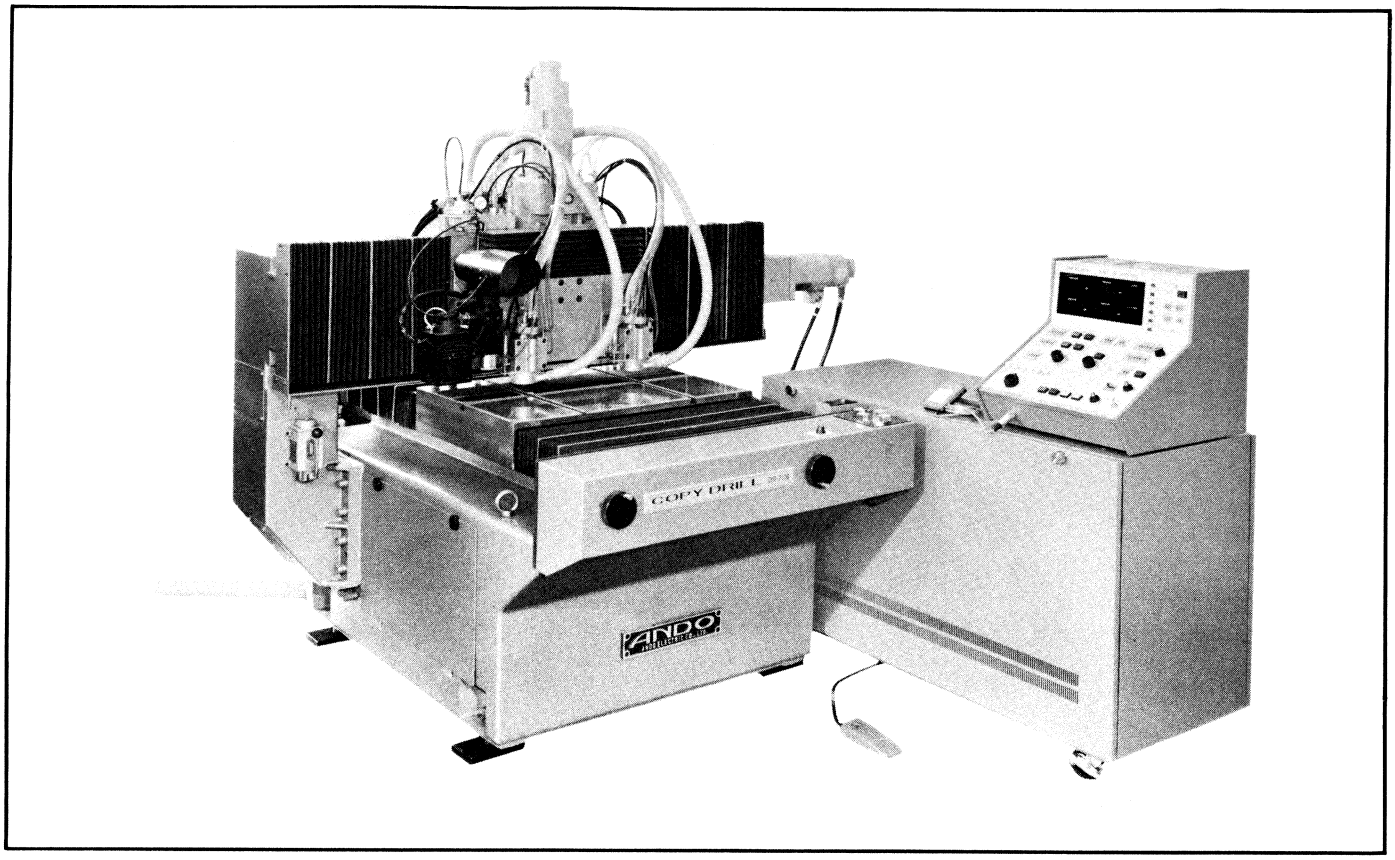
Control axes:	Simultaneous control of X and Y axes
Input method:	Teach-in
Instruction method:	Absolute
Memory capacity:	200 points (expandable)
Minimum setting unit:	0.1
Maximum instruction value:	999.9
Resetting:	Automatic
Hit counter:	Electromagnetic 4-digit counter for each axis
Dimensions:	Approx. 1200x720x500 mm
Weight:	Approx. 120 kg

Options

(1) Damaged tap detector
(2) Magnetic card reader-writer
(3) Sequence setting unit
(4) Keyboard input unit
(5) Memory expansion (200 points)

COPY DRILLS (NC Drilling Machines for PCBs)

TYPES CPD-2110/2120/4000



Ando's copy drills of the CPD-2000 and CPD-4000 series are high-grade boring machines for electronic printed circuit boards that have been provided with automatic NC data read/write capabilities for the first time in the world.

These copy drills combine automatic or manual copying and high-precision drilling functions, and are micro-computer-controlled. The microcomputer control system that has made the tapeless NC drilling machines possible is literally epoch-making. Ando's copy drills that employ the latest advances in NC technology are highly efficient systems suitable for automation and labor saving, which are truly the over-riding needs of users in the 1980s.

These copy drills will do a particularly excellent job in NC data preparation, job lot production of different types of products, and small-hole drilling.

Steps in Operation

- Automatic NC Data Read/Write
  A strip of negative film showing holes of differing diameters is set to the reference position on the table, and the reading optical axis automatically scans the negative. The hole center positions indicated on the negative are automatically written in the copy drill according to the drill size.
- Data Check and Compilation
  The hole position data written in the copy drill memory are as correct as indicated on the negative. If necessary, however, these data can be visually checked, added to, changed, or deleted. Test drilling is also possible.
- Drilling Operation
  Up to 3 printed circuit boards (PCBs) are set on the table at the specified position, the drill is attached, and a start instruction is given. The playback function then immediately starts, repeating the drilling cycle accoridng to the data stored in the memory.
- Data Preservation
  The data stored in the memory are deleted when new data are entered. If the data already stored in the memory are to be preserved, they can be dumped to a digital cassette magnetic tape.

FEATURES

High Productivity and Performance/Cost Ratio

- Time-saving and economical data preparation.
- The equipment is relatively inexpensive. All operations can be performed by one operator. Electric power consumption and running cost are low. Overall, the investment in this copy drill will pay off soon.

TYPES CPD-2110/2120/4000, COPY DRILLS

High Accuracy and High Quality

- Direct memory by automatic copying, a one-piece structure that performs both writing and drilling, a semiclosed positioning control system, an absolute method free from cumulative errors, microcomputer control, autoamtic monitoring, and other up-to-date techniques of Ando havd been incorporated in these series of copy drills. The electronics-oriented NC machines that employ the latest advances in modern technology ensure high reliability of performance.
- High-precision, high-quality NC machines that feature a high hit rate for small-hole drilling and ordinary hole drilling required in the production of high density printed circuit boards.

Easy and Fast Operation

- Anyone can easily operate these copy drills without first receiving any particular education or training. As the down-time required in the preparation of the machine is limited and the machine can be operated with little loss of fine, its productivity in limited production of different types of products is almost as high as that in mass production.
- In addition to the automatic reading function, specific pattern repetition, IC pattern memory, data compilation, coordinate measurement, sequence setting, and other functions can be utilized to a full extent. These various capabilities contribute a great deal to the productivity of these copy drills and help reduce the time required to fill orders.

SPECIFICATIONS

Type			CPD-2110	CPD-2120	CPD-4000
System	Drive motor		High-frequency motor		
	Main spindle drill		1-spindle	2-spindle	4-spindle
General	Data read/write		Automatic and manual		Manual
	Working range		One-spindle for all-plane use : 500 x 500 mm Two-spindle for two-plane use : 340 x 500 mm Four-spindle for four-plane use : 600 x 370 mm		
	Hit rate		300 holes/min (pitch, 2.5 mm; stroke, 2.5 mm)		
	Positioning accuracy		0.01 mm		
	Hole memory capacity		2000 holes, standard (expandable)		
	Boring capacity		0.3 to 2 6 mm (0.3 to 6 mm, special specification)		
Drill Head	Main spindle drive		DC servo motor (NC)		
	Main spindle revolutions		30000 to 72000 rpm		
	Main spindle stroke		0.1 to 9.9 mm (set by a digital switch)		
	Cutting speed		100 to 9900 mm/min (variable by a dial)		
	Drill mounting		Drill chuck diameter: 3.175 mm centrifugal collet (quick-mounting type)		
Drive	Control shaft drive		DC servo motor for all X, Y and Z axes. High precision machined screws are used.		
	Maximum feed		10000 mm/min		
Control	Operation control		Microcomputer		
	Coordinate instruction		Absolute		
	Coordinate indication		Decimal 5-digit display		
	Electronic memory		Internal: IC memory External: Digital cassette magnetic tape		
	Origin correction		Correctable over a range of -2.5 to +99.99 mm by digital switches for X and Y axes.		
Others	Power requirements	Control circuit	100V AC, 50/60 Hz, single-phase, 0.5 kW/h		
		Drive circuit	200 V AC, 50/60 Hz, 3-phase, 5 kW/h		
	Compressed air		Dry air at a pressure of 7.0 kg/cm^2 at a flow rate of 350 Nℓ/min		Dry air at a pressure of 7.0 kg/cm^2 at a flow rate of 700 Nℓ/min
	Environmental conditions		20°C ± 15°C, 80% RH or less		
	Dimensions		Approx. 1750(H) x 2100(W) x 1700(D) mm		Approx. 1850(H) x 3200(W) x 2000(D) mm
	Weight		Approx. 2300 kg	Approx. 2600 kg	Approx. 5000 kg

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