

Technická dokumentace
**Navrch a realizace experimentální úlohy
na měření polohy**

Petr Kovář

2015



Univerzita Tomáše Bati ve Zlíně
Fakulta aplikované informatiky

Obsah

1 Senzory

- 1.1 Hallův senzor Allegro MicroSystem A3518
- 1.2 Optický senzor SHARP GP2Y0A21YK0F
- 1.3 Kapacitní senzor GREEGOO CM30-3010PA
- 1.4 Indukční senzor Lanbao LR30BG10DLO
- 1.5 Potenciometr ALPS RSAON12-10KBX2

2 Měřicí zařízení

- 2.1 Zdroj HAMEG HM8143
- 2.2 Multimetr METEX M-3860M
- 2.3 Multimetr PICOTEST M3510A
- 2.4 Multimetr Agilent 34401A

A3517 and A3518

Ratiometric, Linear Hall-Effect Sensor ICs for High-Temperature Operation

Discontinued Product

These parts are no longer in production. The device should not be purchased for new design applications. Samples are no longer available.

Date of status change: October 31, 2005

Recommended Substitutions:

For new customers or new applications:

- for the A3517, please refer to the Allegro [A1321](#), and
- for the A3518, please refer to the Allegro [A1323](#).

For existing programs only:

- for the A3517, please refer to the Allegro [A3515](#)
A3517LUA is replaced by the A3515LUA
A3517SUA is replaced by the A3515EUA
- for the A3518, please refer to the Allegro [A3516](#)
A3518LUA is replaced by the A3516LUA
A3518SUA is replaced by the A3516EUA

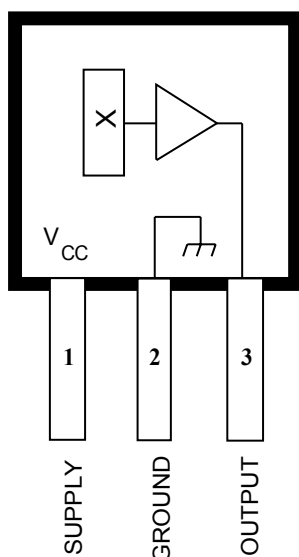
NOTE: For detailed information on purchasing options, contact your local Allegro field applications engineer or sales representative.

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3517 AND 3518

RATIOMETRIC, LINEAR HALL-EFFECT SENSOR ICs FOR HIGH-TEMPERATURE OPERATION



Dwg. PH-006

Pinning is shown viewed from branded side.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{CC}	8.0 V
Output Voltage, V_O	8.0 V
Output Sink Current, I_O	10 mA
Magnetic Flux Density, B	Unlimited
Package Power Dissipation, P_D	See Graph
Operating Temperature Range*, T_A Suffix S-	-20°C to +85°C
Suffix L-	-40°C to +150°C
Storage Temperature Range, T_S	-65°C to +170°C

* Infrequent excursions permitted; see Applications Information.

The A3517xUA and A3518xUA are sensitive, temperature-stable linear Hall-effect sensor ICs with greatly improved offset characteristics. Ratiometric, linear Hall-effect devices provide a voltage output that is proportional to the applied magnetic field and have a quiescent output voltage that is approximately 50% of the supply voltage. These magnetic devices are ideal for use in linear and rotary position sensing systems in the harsh environments of automotive and industrial applications over extended temperatures to -40°C and +150°C. The A3517xUA features an output sensitivity of 5 mV/G while the A3518xUA has an output sensitivity of 2.5 mV/G. See the Magnetic Characteristics table for complete, individual device parametrics.

Each BiCMOS monolithic circuit integrates a Hall element, improved temperature-compensating circuitry to reduce the intrinsic sensitivity drift of the Hall element, a small-signal high-gain amplifier, and a rail-to-rail low-impedance output stage.

A proprietary dynamic offset cancellation technique, with an internal high-frequency clock, reduces the residual offset voltage, which is normally caused by device overmolding, temperature dependancies, and thermal stress. This technique produces devices that have an extremely stable quiescent output voltage, are immune to mechanical stress, and have precise recoverability after temperature cycling. Many problems normally associated with low-level analog signals are minimized by having the Hall element and amplifier in a single chip. Output precision is obtained by internal gain and offset trim adjustments during the manufacturing process.

These reduced-cost devices are supplied in a 3-pin ultra-mini-SIP "UA" package only.

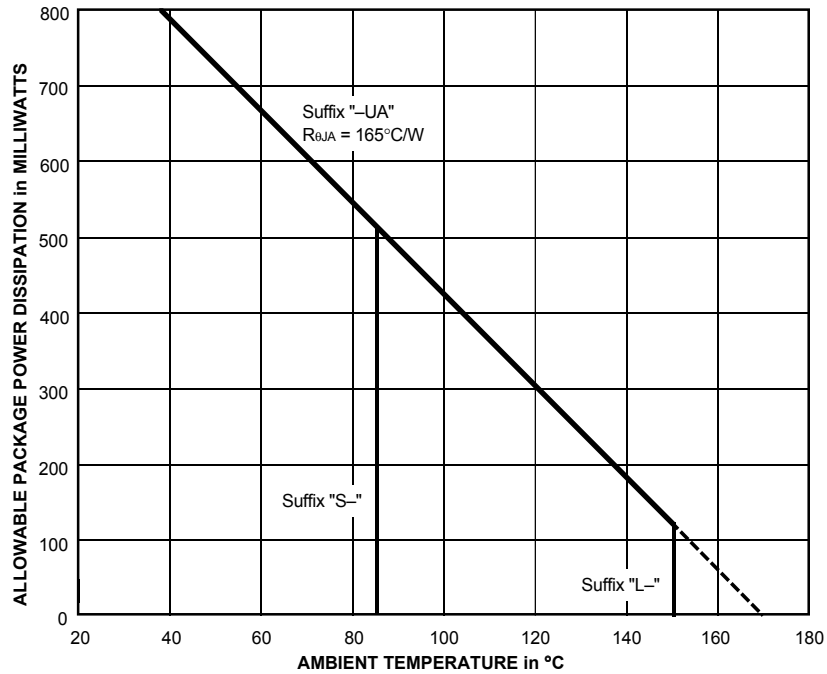
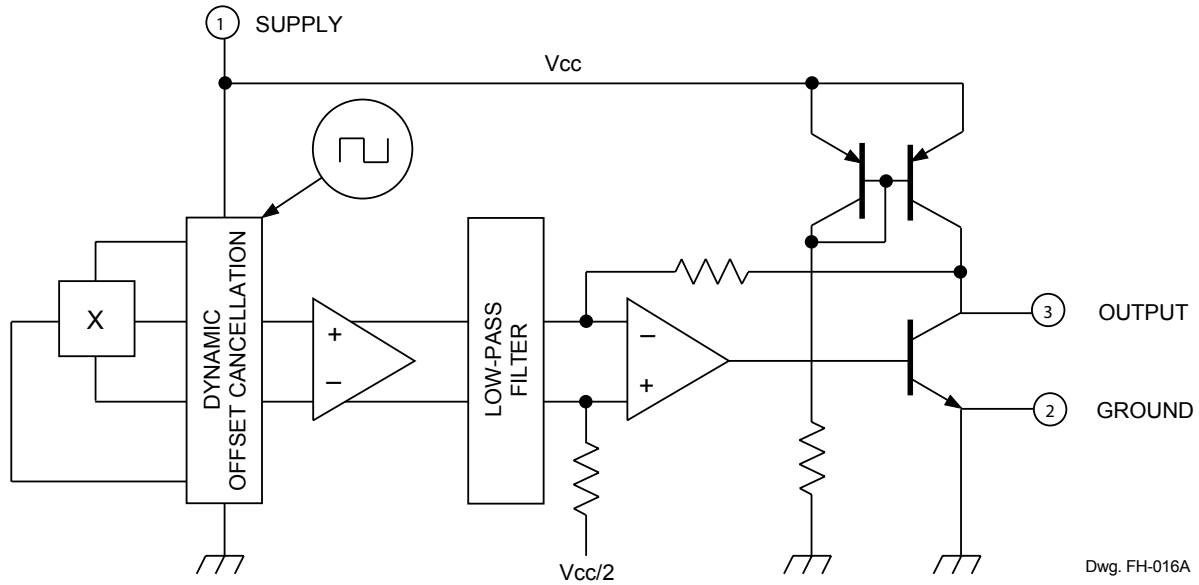
FEATURES

- Temperature-Stable Quiescent Output Voltage
- Precise Recoverability After Temperature Cycling
- Output Voltage Proportional to Applied Magnetic Field
- Ratiometric Rail-to-Rail Output
- Improved Sensitivity
- 4.5 V to 5.5 V Operation
- Immune to Mechanical Stress
- Small Package Size
- Solid-State Reliability

Always order by complete part number, e.g., **A3517SUA**.

3517 AND 3518 RATIOMETRIC, LINEAR HALL-EFFECT SENSOR ICs FOR HIGH-TEMP. OPERATION

FUNCTIONAL BLOCK DIAGRAM



3517 AND 3518
RATIOMETRIC,
LINEAR HALL-EFFECT SENSOR ICs
FOR HIGH-TEMP. OPERATION

ELECTRICAL CHARACTERISTICS over operating temperature range, at $V_{CC} = 5\text{ V}$ (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Limits			
			Min.	Typ.	Max.	Units
Supply Voltage	V_{CC}	Operating	4.5	5.0	5.5	V
Supply Current	I_{CC}	$B = 0, V_{CC} = 6\text{ V}, I_O = 0$	–	7.2	12	mA
Quiescent Voltage Output	V_{OQ}	$B = 0, I_O = 1\text{ mA}, T_A = 25^\circ\text{C}$	2.2	2.5	2.8	V
Output Voltage	V_{OH}	$B = +X^*, I_O = 1\text{ mA}$	–	4.7	–	V
	V_{OL}	$B = -X^*, I_O = -1\text{ mA}$	–	0.2	–	V
Output Source Current Limit	I_{OLM}	$B = -X^*, V_O = 0$	-1.0	-1.5	–	mA
Bandwidth (-3 dB)	BW		–	30	–	kHz
Clock Frequency	f_C		–	170	–	kHz
Output Resistance	r_O	$I_O \leq -2\text{ mA}$	–	1.0	–	Ω
Wide-Band Output Noise (rms)	e_o	$B = 0, BW = 10\text{ Hz to }10\text{ kHz}, I_O \leq -1\text{ mA}, C_O = 100\text{ pF}$	–	400	–	μV

NOTE 1 – Typical data is at $T_A = 25^\circ\text{C}$ and is for design information only.

NOTE 2 – Negative current is defined as coming out of (sourcing) the output.

* This test requires positive and negative fields sufficient to swing the output driver between fully OFF and saturated (ON), respectively. It is NOT intended to indicate a range of linear operation.

**3517 AND 3518
RATIOMETRIC,
LINEAR HALL-EFFECT SENSOR ICS
FOR HIGH-TEMP. OPERATION**

MAGNETIC CHARACTERISTICS over operating temperature range, at $V_{CC} = 5\text{ V}$, $I_O = -1\text{ mA}$ (unless otherwise noted).

Characteristic*	Part Numbers												Units
	A3517SUA			A3517LUA			A3518SUA			A3518LUA			
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Operating Temp. Range, T_A	-20	-	+85	-40	-	+150	-20	-	+85	-40	-	+150	°C
Sensitivity at $T_A = 25^\circ\text{C}$	4.0	5.0	6.0	4.0	5.0	6.0	2.0	2.5	3.0	2.0	2.5	3.0	mV/G
$\Delta\text{Sens}_{(\Delta T)}$ at $T_A = \text{Max.}$	-5.0	2.5	10	-5.0	2.5	10	-5.0	2.5	10	-5.0	2.5	10	%
$\Delta\text{Sens}_{(\Delta T)}$ at $T_A = \text{Min.}$	-9.0	-1.3	6.0	-9.0	-1.3	6.0	-9.0	-1.3	6.0	-9.0	-1.3	6.0	%
$\Delta V_{OQ(\Delta T)}^\dagger$	-	-	± 20	-	-	± 20	-	-	± 20	-	-	± 20	G
Ratiometry, $\Delta V_{OQ(\Delta V)}$	-	100	-	-	100	-	-	100	-	-	100	-	%
Ratiometry, $\Delta\text{Sens}_{(\Delta V)}$	-	100	-	-	100	-	-	100	-	-	100	-	%
Positive Linearity, Lin+	-	100	-	-	100	-	-	100	-	-	100	-	%
Negative Linearity, Lin-	-	100	-	-	100	-	-	100	-	-	100	-	%
Symmetry	-	100	-	-	100	-	-	100	-	-	100	-	%

NOTE 1 – Magnetic flux density is measured at most sensitive area of device located 0.018" (0.46 mm) below the branded face of the package.

NOTE 2 – 10 G = 1 mT, exactly.

NOTE 3 – Except for $\Delta\text{Sens}_{(\Delta T)}$, typical data is at $T_A = 25^\circ\text{C}$ and is for design information only.

* See Characteristics Definitions for test conditions.

† This calculation (formula 1, next page) yields the device's equivalent accuracy, over the operating temperature range, in gauss.

3517 AND 3518 RATIOMETRIC, LINEAR HALL-EFFECT SENSOR ICs FOR HIGH-TEMP. OPERATION

CHARACTERISTICS DEFINITIONS

Quiescent Voltage Output. In the quiescent state (no magnetic field), the output is ideally equal to one-half of the supply voltage over the operating voltage and temperature range ($V_{OQ} \approx V_{CC}/2$). Due to internal component tolerances and thermal considerations, there is a tolerance on the quiescent voltage output and on the quiescent voltage output as a function of supply voltage and ambient temperature. For purposes of specification, the quiescent voltage output as a function of temperature is defined as

$$\Delta V_{OQ(\Delta T)} = \frac{V_{OQ(TA)} - V_{OQ(25^{\circ}C)}}{Sens_{(25^{\circ}C)}} \quad (1)$$

This calculation yields the device's equivalent accuracy, over the operating temperature range, in gauss.

Sensitivity. The presence of a south-pole magnetic field perpendicular to the package face (the branded surface) will increase the output voltage from its quiescent value toward the supply voltage rail by an amount proportional to the magnetic field applied. Conversely, the application of a north pole will decrease the output voltage from its quiescent value. This proportionality is specified as the sensitivity of the device and is defined as

$$Sens = \frac{V_{O(500G)} - V_{O(-500G)}}{1000 \text{ G}} \quad (2)$$

The stability of sensitivity as a function of temperature is defined as

$$\Delta Sens_{(\Delta T)} = \frac{Sens_{(TA)} - Sens_{(25^{\circ}C)}}{Sens_{(25^{\circ}C)}} \times 100\% \quad (3)$$

Ratiometry. The A3517xUA and A3518xUA feature a ratiometric output. The quiescent voltage output and sensitivity are proportional to the supply voltage (ratiometric).

The per cent ratiometric change in the quiescent voltage output is defined as

$$\Delta V_{OQ(\Delta V)} = \frac{V_{OQ(VCC)} / V_{OQ(5V)}}{V_{CC} / 5 \text{ V}} \times 100\% \quad (4)$$

and the per cent ratiometric change in sensitivity is defined as

$$\Delta Sens_{(\Delta V)} = \frac{Sens_{(VCC)} / Sens_{(5V)}}{V_{CC} / 5 \text{ V}} \times 100\% \quad (5)$$

Linearity and Symmetry. The on-chip output stage is designed to provide a linear output to within 500 mV of either rail with a supply voltage of 5 V. This is equivalent to approximately ± 800 gauss of ambient field. Although application of stronger magnetic fields will not damage these devices, it will force the output into a non-linear region. Linearity in per cent is measured and defined as

$$Lin+ = \frac{V_{O(500G)} - V_{OQ}}{2 (V_{O(250G)} - V_{OQ})} \times 100\% \quad (6)$$

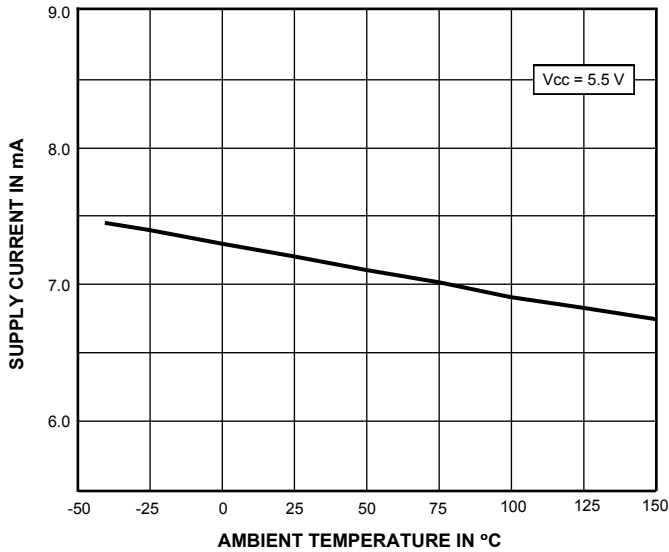
$$Lin- = \frac{V_{O(-500G)} - V_{OQ}}{2 (V_{O(-250G)} - V_{OQ})} \times 100\% \quad (7)$$

and output symmetry as

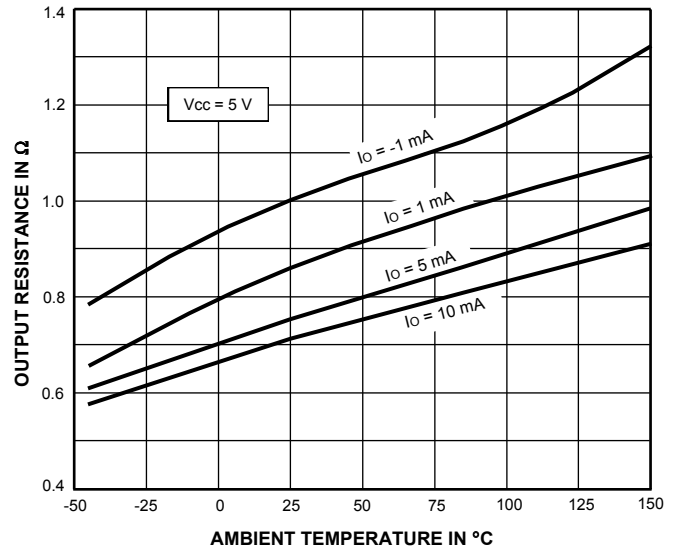
$$Sym = \frac{V_{O(500G)} - V_{OQ}}{V_{OQ} - V_{O(-500G)}} \times 100\% \quad (8)$$

3517 AND 3518 RATIOMETRIC, LINEAR HALL-EFFECT SENSOR ICs FOR HIGH-TEMP. OPERATION

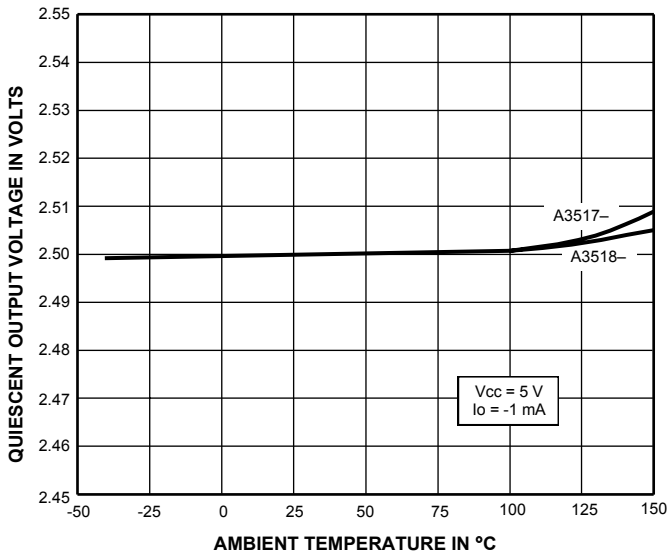
TYPICAL CHARACTERISTICS



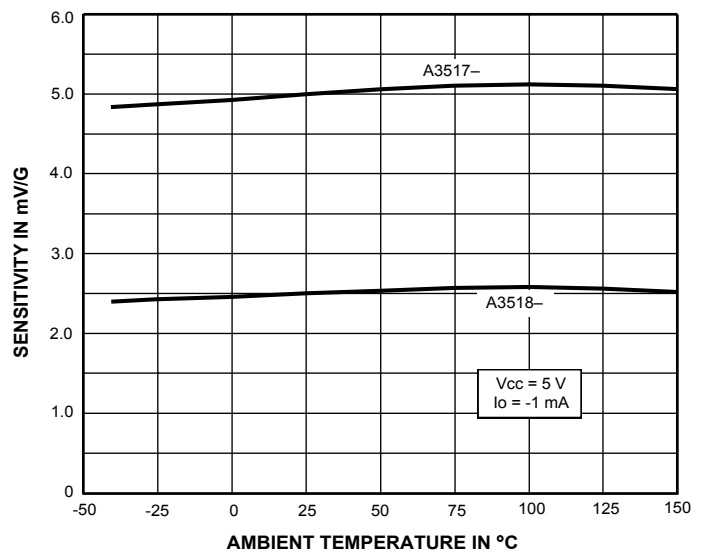
Dwg. GH-039-2



Dwg. GH-060-1



Dwg. GH-067-1



Dwg. GH-066-1

**3517 AND 3518
RATIOMETRIC,
LINEAR HALL-EFFECT SENSOR ICs
FOR HIGH-TEMP. OPERATION**

CRITERIA FOR DEVICE QUALIFICATION

All Allegro devices are subjected to stringent qualification requirements prior to being released to production. To become qualified, except for the destructive ESD tests, no failures are permitted.

Qualification Test	Test Method and Test Conditions	Test Length	Samples	Comments
Temperature Humidity Bias Life	JESD22-A101 $T_A = 85^{\circ}\text{C}$, RH = 85%	1000 hrs	77	Device biased for minimum power
Bias Life	JESD22-A108 $T_A = 150^{\circ}\text{C}$, $T_J = 165^{\circ}\text{C}$	1000 hrs	77	
(Surge Operating Life)	JESD22-A108 $T_A = 175^{\circ}\text{C}$, $T_J = 190^{\circ}\text{C}$	168 hrs	77	
Autoclave, Unbiased	JESD22-A102 $T_A = 121^{\circ}\text{C}$, 15 psig	96 hrs	77	
High-Temperature (Bake) Storage Life	JESD22-A103 $T_A = 170^{\circ}\text{C}$	1000 hrs	77	
Temperature Cycle	JESD22-A104	1000 cycles	77	
ESD, Human Body Model	CDF-AEC-Q100-002	Pre/Post Reading	3 per test	Test to failure All leads > 3 kV

3517 AND 3518 RATIOMETRIC, LINEAR HALL-EFFECT SENSOR ICS FOR HIGH-TEMP. OPERATION

APPLICATIONS INFORMATION

Calibrated linear Hall devices, which can be used to determine the actual flux density presented to the device in a particular application, are available.

For safe, reliable operation, the output should not be pulled above the supply voltage or pulled below the device ground.

For optimum performance, a 0.1 μF capacitor between the supply and ground, and a 100 pF capacitor between the output and ground, should be added.

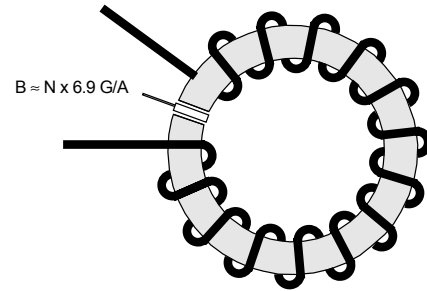
The ratiometric feature is especially valuable when these devices are used with an analog-to-digital converter. A/D converters typically derive their LSB step size by ratioing off a reference voltage line. If the reference voltage varies, the LSB will vary proportionally. This is a major error source in many sensing systems. The A3517xUA and A3518xUA can eliminate this source of error by their ratiometric operation. Because their gain and offsets are proportional to the supply voltage, if they are powered from the A/D reference voltage, the device output voltage will track changes in the LSB value.

These devices can withstand infrequent temperature excursions, beyond the Absolute Maximum Ratings, to $T_A = 170^\circ\text{C}$ provided the junction temperature, T_J , does not exceed 200°C .

Extensive applications information on Hall-effect devices and magnets is also available in the "Hall-Effect IC Applications Guide", which can be found in the latest issue of the *Allegro MicroSystems Electronic Data Book*, AMS-702 or *Application Note 27701*, or at

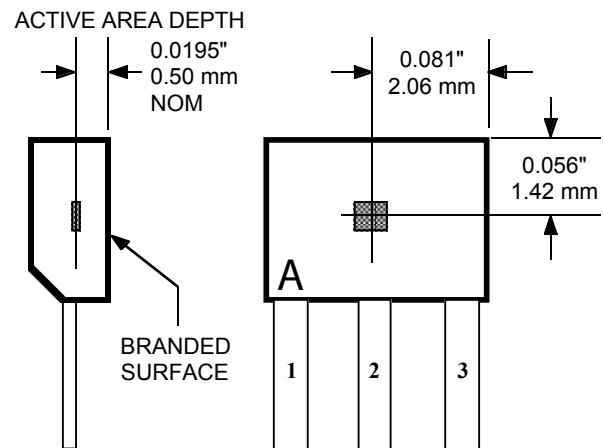
www.allegromicro.com

TYPICAL CURRENT-SENSING APPLICATION



Dwg. AH-005A

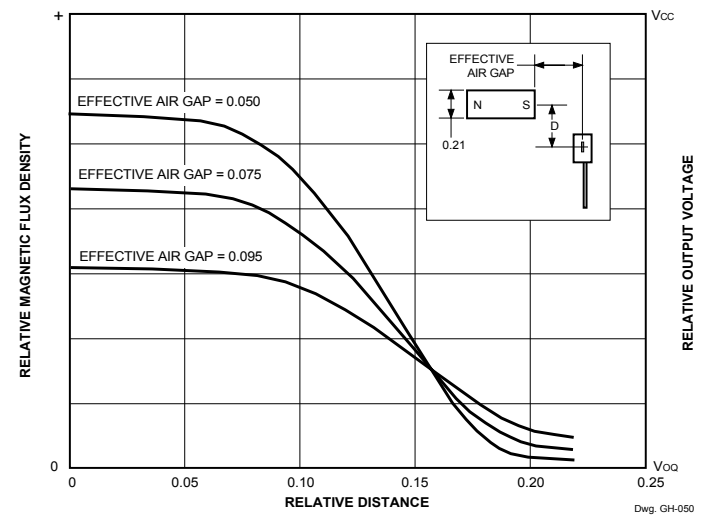
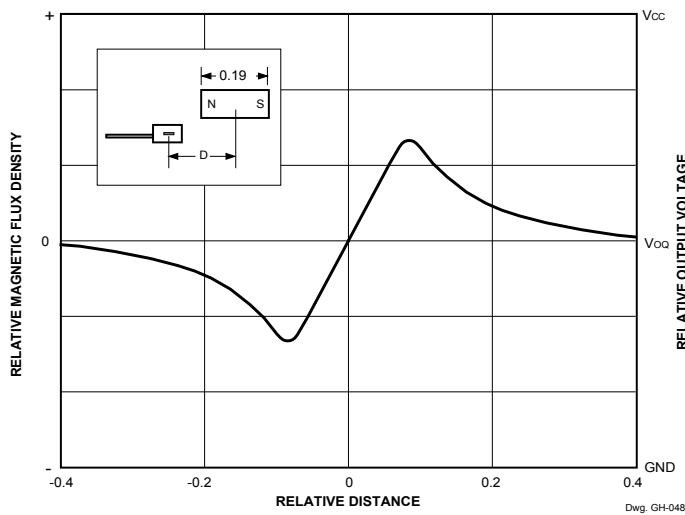
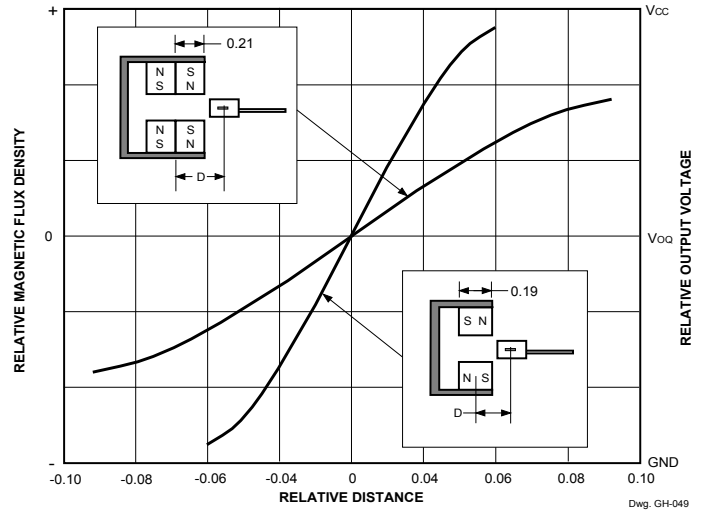
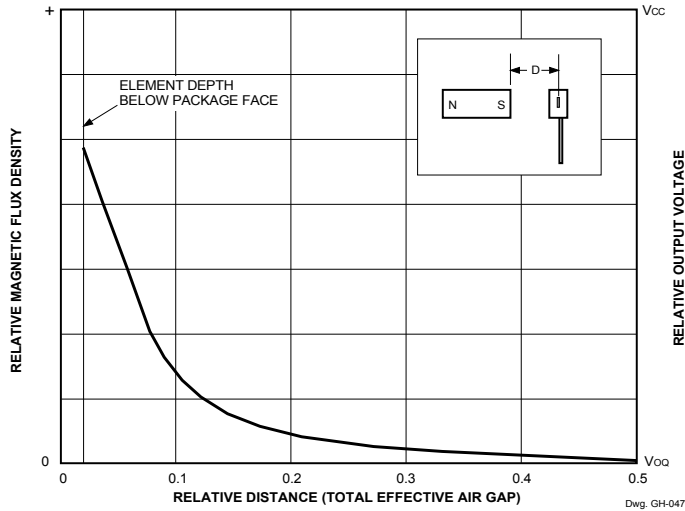
ELEMENT LOCATION



Dwg. MH-011-7A

3517 AND 3518 RATIOMETRIC, LINEAR HALL-EFFECT SENSOR ICs FOR HIGH-TEMP. OPERATION

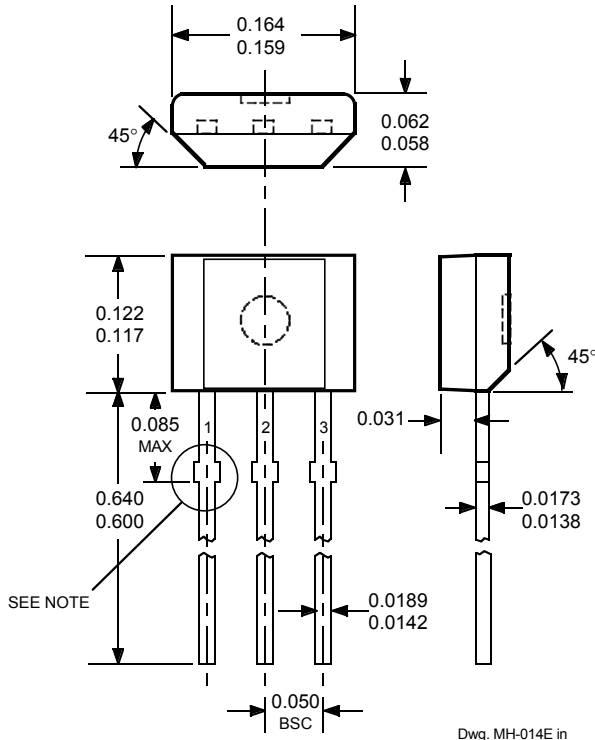
TYPICAL POSITION-SENSING APPLICATIONS (Alnico 8, dimensions in inches)



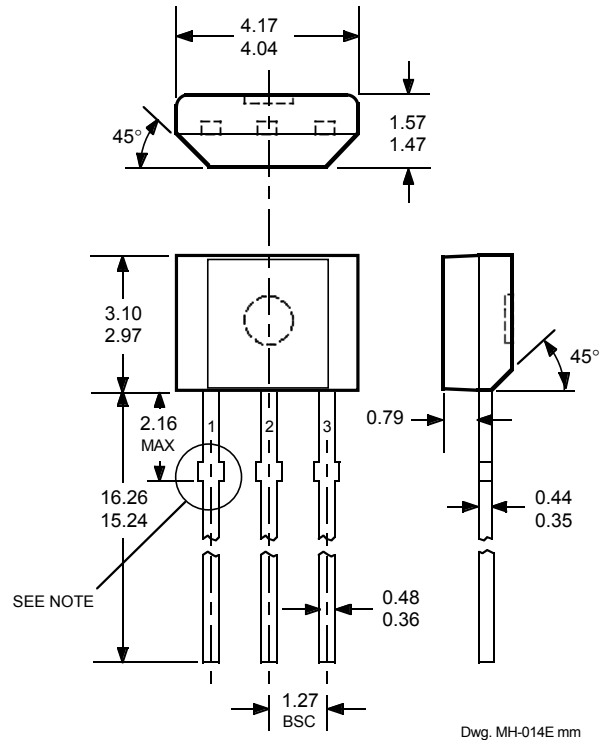
3517 AND 3518 RATIOMETRIC, LINEAR HALL-EFFECT SENSOR ICS FOR HIGH-TEMP. OPERATION

A3517xUA and A3518xUA

Dimensions in Inches
(controlling dimensions)

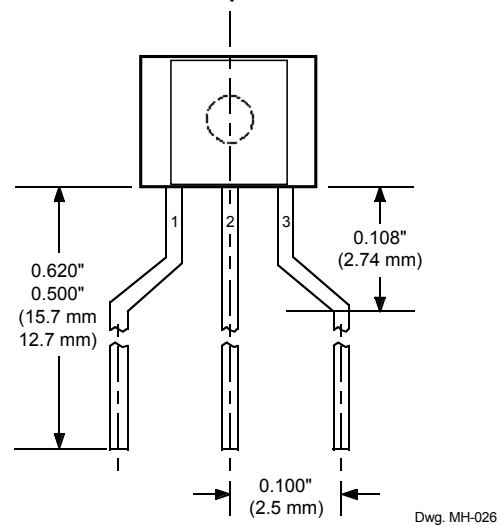


Dimensions in Millimeters
(for reference only)



- NOTES:
1. Tolerances on package height and width represent allowable mold offsets. Dimensions given are measured at the widest point (parting line).
 2. Exact body and lead configuration at vendor's option within limits shown.
 3. Height does not include mold gate flash.
 4. Recommended minimum PWB hole diameter to clear transition area is 0.035" (0.89 mm).
 5. Where no tolerance is specified, dimension is nominal.
 6. Supplied in bulk pack (500 pieces per bag).

Radial Lead Form (order A351xxUA-LC)

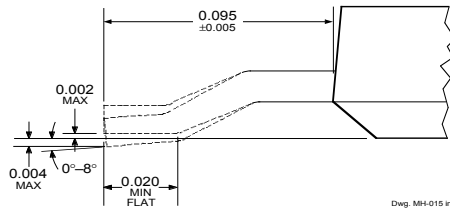


NOTE: Lead-form dimensions are the nominals produced on the forming equipment. No dimensional tolerance is implied or guaranteed for bulk packaging (500 pieces per bag).

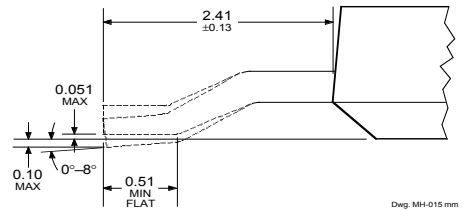
3517 AND 3518 RATIOMETRIC, LINEAR HALL-EFFECT SENSOR ICs FOR HIGH-TEMP. OPERATION

Horizontal-Mount Lead Form (add '-TL' to part number)

Dimensions in Inches
(controlling dimensions)



Dimensions in Millimeters
(for reference only)



NOTE: Supplied in bulk pack (500 devices per bag).

The products described herein are manufactured under one or more of the following U.S. patents: 5,045,920; 5,264,783; 5,442,283; 5,389,889; 5,581,179; 5,517,112; 5,619,137; 5,621,319; 5,650,719; 5,686,894; 5,694,038; 5,729,130; 5,917,320; and other patents pending.

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**3517 AND 3518
RATIOMETRIC,
LINEAR HALL-EFFECT SENSOR ICS
FOR HIGH-TEMP. OPERATION**

HALL-EFFECT SENSOR ICS

LINEAR HALL-EFFECT SENSOR ICS						
Partial Part Number	Supply Voltage (V)	Typical Sensitivity	Equivalent Accuracy (see note 3)	Oper. Temp.	Packages	Comments
UGN3503	4.5 to 6	1.3 mV/G	—	S	LT, UA	
A3515x	4.5 to 5.5	5 mV/G	<±10 G	E, L	UA	chopper stabilized
A3516x	4.5 to 5.5	2.5 mV/G	<±10 G	E, L	UA	chopper stabilized
A3517x	4.5 to 5.5	5 mV/G	<±20 G	S, L	UA	chopper stabilized
A3518x	4.5 to 5.5	2.5 mV/G	<±20 G	S, L	UA	chopper stabilized

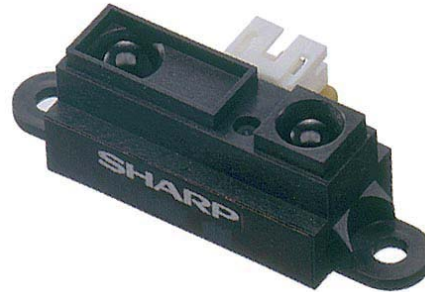
Notes: 1) Typical data is at $T_A = +25^\circ\text{C}$ and nominal operating voltage.

2) "x" = Operating Temperature Range [suffix letter or (prefix)]: S (UGN) = -20°C to $+85^\circ\text{C}$, E = -40°C to $+85^\circ\text{C}$, J = -40°C to $+115^\circ\text{C}$, K (UGS) = -40°C to $+125^\circ\text{C}$, L (UGL) = -40°C to $+150^\circ\text{C}$.

3) Linear Hall-effect equivalent accuracy is defined as ΔV_{OQ} over the operating temperature range, divided by sensitivity.

GP2Y0A21YK0F

Distance Measuring Sensor Unit
Measuring distance: 10 to 80 cm
Analog output type



■Description

GP2Y0A21YK0F is a distance measuring sensor unit, composed of an integrated combination of PSD (position sensitive detector), IRED (infrared emitting diode) and signal processing circuit.

The variety of the reflectivity of the object, the environmental temperature and the operating duration are not influenced easily to the distance detection because of adopting the triangulation method.

This device outputs the voltage corresponding to the detection distance. So this sensor can also be used as a proximity sensor.

■Features

1. Distance measuring range : 10 to 80 cm
2. Analog output type
3. Package size : 29.5×13×13.5 mm
4. Consumption current : Typ. 30 mA
5. Supply voltage : 4.5 to 5.5 V

■Agency approvals/Compliance

1. Compliant with RoHS directive (2002/95/EC)

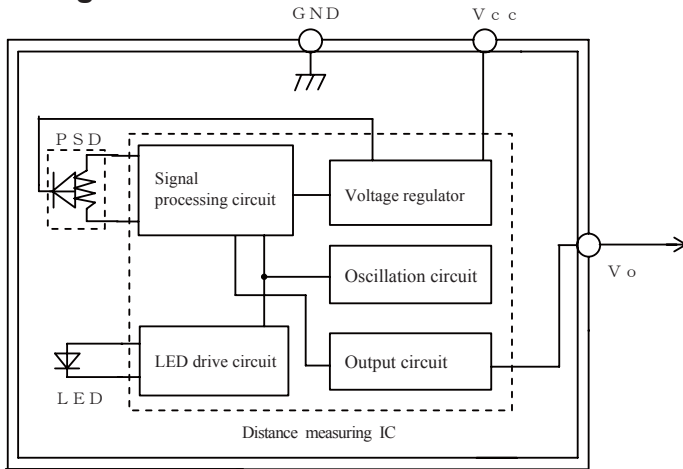
■Applications

1. Touch-less switch
(Sanitary equipment, Control of illumination, etc.)
2. Robot cleaner
3. Sensor for energy saving
(ATM, Copier, Vending machine)
4. Amusement equipment
(Robot, Arcade game machine)

Notice The content of data sheet is subject to change without prior notice.

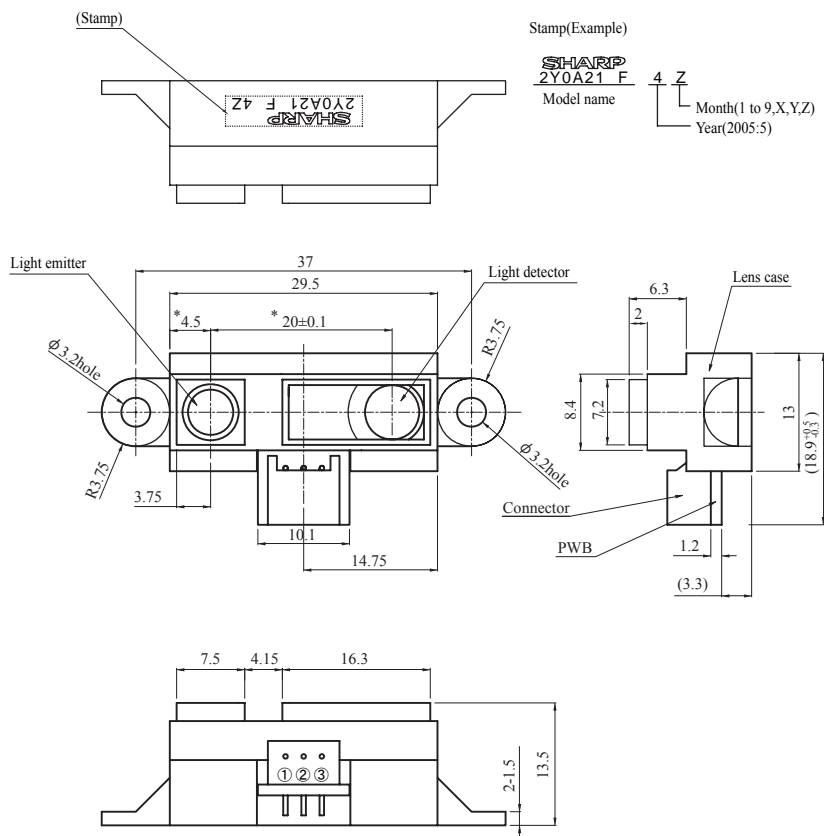
In the absence of confirmation by device specification sheets, SHARP takes no responsibility for any defects that may occur in equipment using any SHARP devices shown in catalogs, data books, etc. Contact SHARP in order to obtain the latest device specification sheets before using any SHARP device.

Block diagram



Outline Dimensions

(Unit : mm)



Connector signal

①	signal name
①	V _o
②	GND
③	V _{cc}

Connector :
J.S.T. TRADING COMPANY, LTD,
S3B-PH

Materials

Lens : Acrylic acid resin
(Visible light cut-off resin)
Case : Carbonic ABS
(Conductive resin)
PWB : Paper phenol

Note 1. The dimensions marked * are described the dimensions of lens center position.

Note 2. Unspecified tolerances shall be ± 0.3 mm.

Note 3. The dimensions in parenthesis are shown for reference.

Product mass : Approx. 3.6g

■ Absolute Maximum Ratings (T_a=25°C, V_{CC}=5V)

Parameter	Symbol	Rating	Unit
Supply voltage	V _{CC}	-0.3 to +7	V
Output terminal voltage	V _O	-0.3 to V _{CC} +0.3	V
Operating temperature	T _{opr}	-10 to +60	°C
Storage temperature	T _{stg}	-40 to +70	°C

■ Electro-optical Characteristics (T_a=25°C, V_{CC}=5V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Average supply current	I _{CC}	L=80cm (Note 1)	—	30	40	mA
Distance measuring	ΔL	(Note 1)	10	—	80	cm
Output voltage	V _O	L=80cm (Note 1)	0.25	0.4	0.55	V
Output voltage differential	ΔV _O	Output voltage difference between L=10cm and L=80cm (Note 1)	1.65	1.9	2.15	V

* L : Distance to reflective object

Note 1 : Using reflective object : White paper (Made by Kodak Co., Ltd. gray cards R-27·white face, reflectance; 90%)

■ Recommended operating conditions

Parameter	Symbol	Rating	Unit
Supply voltage	V _{CC}	4.5 to 5.5	V

Fig. 1 Timing chart

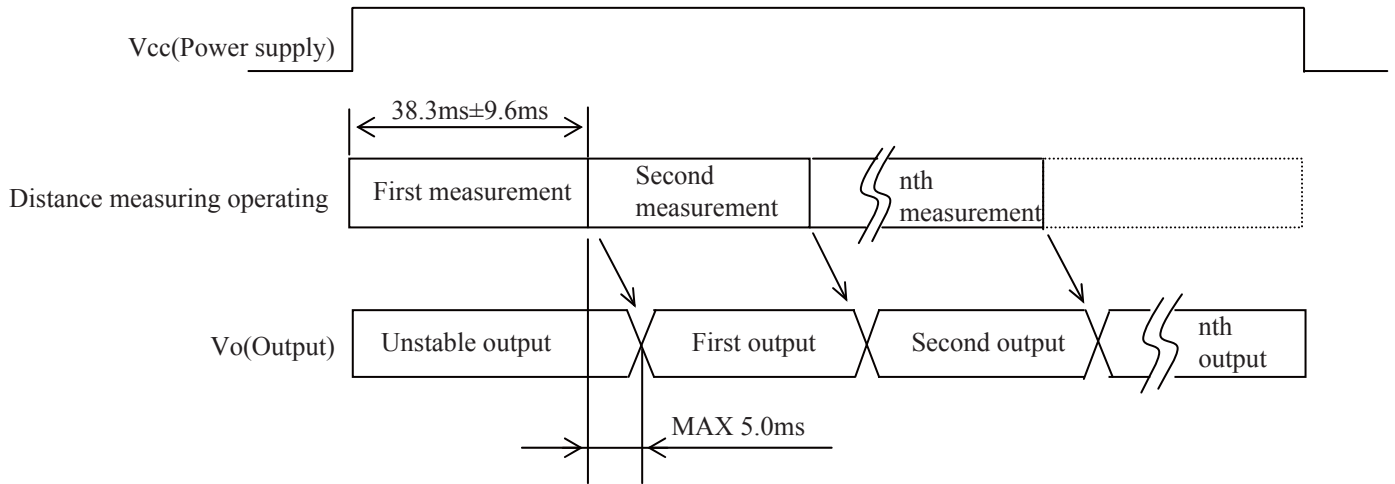
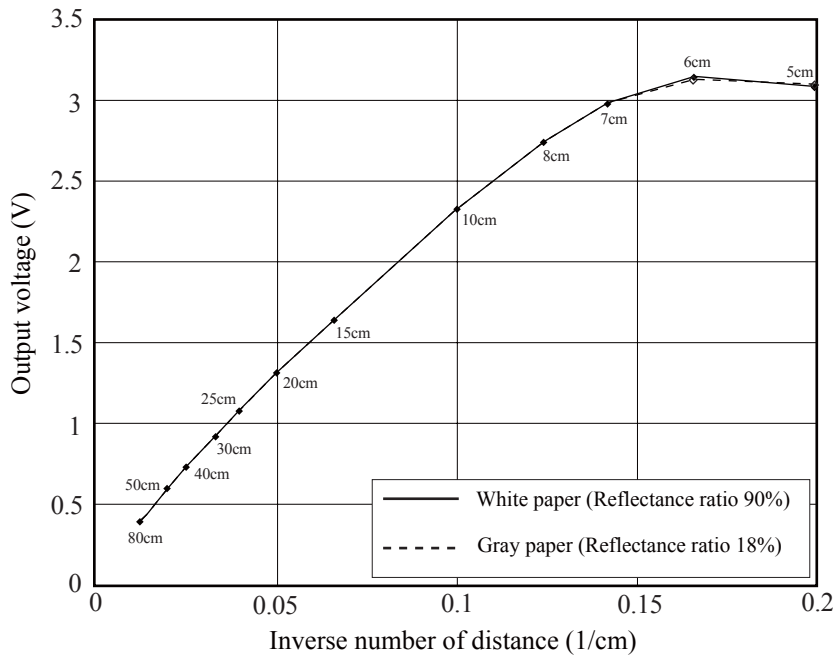
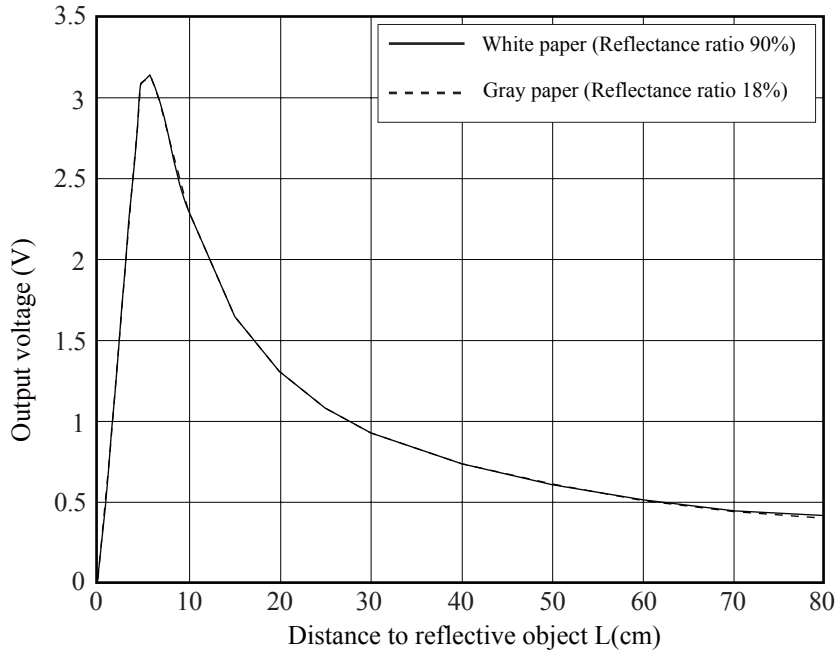


Fig. 2 Example of distance measuring characteristics(output)



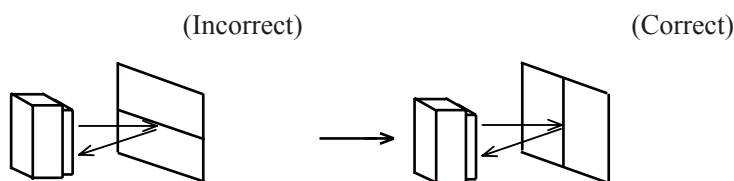
■ Notes

● Advice for the optics

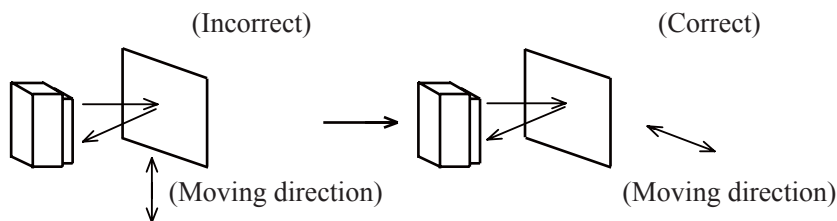
- The lens of this device needs to be kept clean. There are cases that dust, water or oil and so on deteriorate the characteristics of this device. Please consider in actual application.
- Please don't do washing. Washing may deteriorate the characteristics of optical system and so on. Please confirm resistance to chemicals under the actual usage since this product has not been designed against washing.

● Advice for the characteristics

- In case that an optical filter is set in front of the emitter and detector portion, the optical filter which has the most efficient transmittance at the emitting wavelength range of LED for this product ($\lambda = 870 \pm 70\text{nm}$), shall be recommended to use. Both faces of the filter should be mirror polishing. Also, as there are cases that the characteristics may not be satisfied according to the distance between the protection cover and this product or the thickness of the protection cover, please use this product after confirming the operation sufficiently in actual application.
- In case that there is an object near to emitter side of the sensor between sensor and a detecting object, please use this device after confirming sufficiently that the characteristics of this sensor do not change by the object.
- When the detector is exposed to the direct light from the sun, tungsten lamp and so on, there are cases that it can not measure the distance exactly. Please consider the design that the detector is not exposed to the direct light from such light source.
- Distance to a mirror reflector can not be sometimes measured exactly. In case of changing the mounting angle of this product, it may measure the distance exactly.
- In case that reflective object has boundary line which material or color etc. are excessively different, in order to decrease deviation of measuring distance, it shall be recommended to set the sensor that the direction of boundary line and the line between emitter center and detector center are in parallel.



- In order to decrease deviation of measuring distance by moving direction of the reflective object, it shall be recommended to set the sensor that the moving direction of the object and the line between emitter center and detector center are vertical.



● Advice for the power supply

- In order to stabilize power supply line, we recommend to insert a by-pass capacitor of 10 μF or more between Vcc and GND near this product.

● Notes on handling

- There are some possibilities that the internal components in the sensor may be exposed to the excessive mechanical stress. Please be careful not to cause any excessive pressure on the sensor package and also on the PCB while assembling this product.

● Presence of ODC etc.

This product shall not contain the following materials.

And they are not used in the production process for this product.

Regulation substances : CFCs, Halon, Carbon tetrachloride, 1.1.1-Trichloroethane (Methylchloroform)

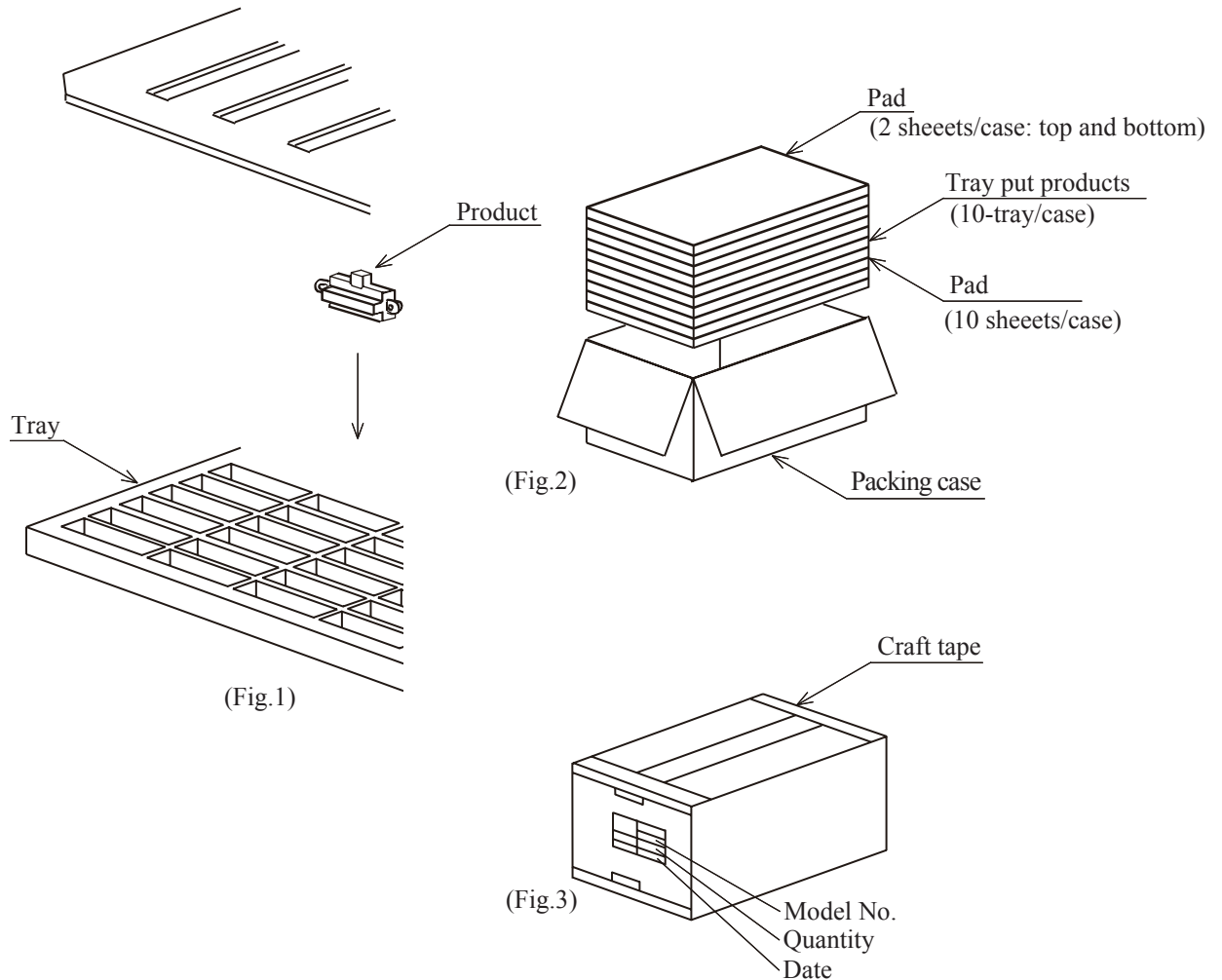
Specific brominated flame retardants such as the PBB and PBDE are not used in this product at all.

This product shall not contain the following materials banned in the RoHS Directive (2002/95/EC).

- Lead, Mercury, Cadmium, Hexavalent chromium, Polybrominated biphenyls (PBB), Polybrominated diphenyl ethers (PBDE).

■ **Package specification**

Package composition



Packaging method

1. Put products of 100pcs. in tray. packing method is showed in the above fig.(Fig.1)
2. Put them(10-tray) in the packing box. Put pads on their top and bottom.
And put pads on each trays(Total 10 sheets) (Fig.2).
3. Seal the packing box with craft tape.
Print the model No.,quantity,inspection date (1000 pcs./a packing box)(Fig.3).

■ Important Notices

· The circuit application examples in this publication are provided to explain representative applications of SHARP devices and are not intended to guarantee any circuit design or license any intellectual property rights. SHARP takes no responsibility for any problems related to any intellectual property right of a third party resulting from the use of SHARP's devices.

· Contact SHARP in order to obtain the latest device specification sheets before using any SHARP device. SHARP reserves the right to make changes in the specifications, characteristics, data, materials, structure, and other contents described herein at any time without notice in order to improve design or reliability. Manufacturing locations are also subject to change without notice.

· Observe the following points when using any devices in this publication. SHARP takes no responsibility for damage caused by improper use of the devices which does not meet the conditions and absolute maximum ratings to be used specified in the relevant specification sheet nor meet the following conditions:

(i) The devices in this publication are designed for use in general electronic equipment designs such as:

- Personal computers
- Office automation equipment
- Telecommunication equipment [terminal]
- Test and measurement equipment
- Industrial control
- Audio visual equipment
- Consumer electronics

(ii) Measures such as fail-safe function and redundant design should be taken to ensure reliability and safety when SHARP devices are used for or in connection

with equipment that requires higher reliability such as:

- Transportation control and safety equipment (i.e., aircraft, trains, automobiles, etc.)
- Traffic signals
- Gas leakage sensor breakers
- Alarm equipment
- Various safety devices, etc.

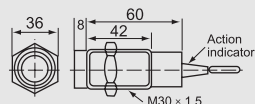
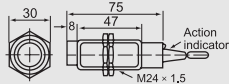
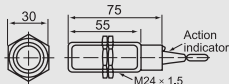
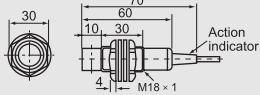
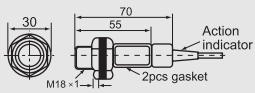
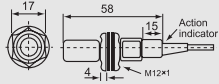
(iii) SHARP devices shall not be used for or in connection with equipment that requires an extremely high level of reliability and safety such as:

- Space applications
- Telecommunication equipment [trunk lines]
- Nuclear power control equipment
- Medical and other life support equipment (e.g., scuba).

· If the SHARP devices listed in this publication fall within the scope of strategic products described in the Foreign Exchange and Foreign Trade Law of Japan, it is necessary to obtain approval to export such SHARP devices.

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· Contact and consult with a SHARP representative if there are any questions about the contents of this publication.



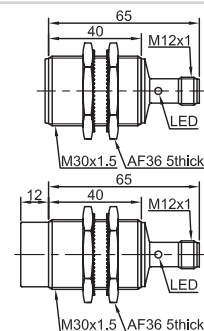
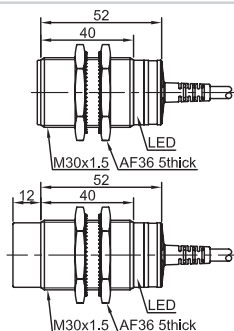
Model No.	Detection distance	Operating voltage	Output		Mounting method	Response frequency
			Method	Status		
CM12-3004NA	0.4mm	DC6-36V	NPN	NO	Non-flush	50Hz
CM12-3004NB	0.4mm	DC6-36V	NPN	NC	Non-flush	50Hz
CM12-3004PA	0.4mm	DC6-36V	PNP	NO	Non-flush	50Hz
CM12-3004PB	0.4mm	DC6-36V	PNP	NC	Non-flush	50Hz
CM18-3005NA	0.5mm	DC6-36V	NPN	NO	Flush	50Hz
CM18-3005NB	0.5mm	DC6-36V	NPN	NC	Flush	50Hz
CM18-3005NC	0.5mm	DC6-36V	NPN	NO+NC	Flush	50Hz
CM18-3005PA	0.5mm	DC6-36V	PNP	NO	Flush	50Hz
CM18-3005PB	0.5mm	DC6-36V	PNP	NC	Flush	50Hz
CM18-3005PC	0.5mm	DC6-36V	PNP	NO+NC	Flush	50Hz
CM18-2005A	0.5mm	AC90-250V	SCR	NO	Flush	10Hz
CM18-2005B	0.5mm	AC90-250V	SCR	NC	Flush	10Hz
CM18-3008NA	0.8mm	DC6-36V	NPN	NO	Non-flush	50Hz
CM18-3008NB	0.8mm	DC6-36V	NPN	NC	Non-flush	50Hz
CM18-3008NC	0.8mm	DC6-36V	NPN	NO+NC	Non-flush	50Hz
CM18-3008PA	0.8mm	DC6-36V	PNP	NO	Non-flush	50Hz
CM18-3008PB	0.8mm	DC6-36V	PNP	NC	Non-flush	50Hz
CM18-3008PC	0.8mm	DC6-36V	PNP	NO+NC	Non-flush	50Hz
CM18-2008A	0.8mm	AC90-250V	SCR	NO	Non-flush	10Hz
CM18-2008B	0.8mm	AC90-250V	SCR	NC	Non-flush	10Hz
CM24-3008NA	0.8mm	DC6-36V	NPN	NO	Flush	50Hz
CM24-3008NB	0.8mm	DC6-36V	NPN	NC	Flush	50Hz
CM24-3008NC	0.8mm	DC6-36V	NPN	NO+NC	Flush	50Hz
CM24-3008PA	0.8mm	DC6-36V	PNP	NO	Flush	50Hz
CM24-3008PB	0.8mm	DC6-36V	PNP	NC	Flush	50Hz
CM24-3008PC	0.8mm	DC6-36V	PNP	NO+NC	Flush	50Hz
CM24-2008A	0.8mm	AC90-250V	SCR	NO	Flush	10Hz
CM24-2008B	0.8mm	AC90-250V	SCR	NC	Flush	10Hz
CM24-3012NA	0-12mm	DC6-36V	NPN	NO	Non-flush	50Hz
CM24-3012NB	0-12mm	DC6-36V	NPN	NC	Non-flush	50Hz
CM24-3012NC	0-12mm	DC6-36V	NPN	NO+NC	Non-flush	50Hz
CM24-3012PA	0-12mm	DC6-36V	PNP	NO	Non-flush	50Hz
CM24-3012PB	0-12mm	DC6-36V	PNP	NC	Non-flush	50Hz
CM24-3012PC	0-12mm	DC6-36V	PNP	NO+NC	Non-flush	50Hz
CM24-2012A	0-12mm	AC90-250V	SCR	NO	Non-flush	10Hz
CM24-2012B	0-12mm	AC90-250V	SCR	NC	Non-flush	10Hz
CM30-3010NA	0-10mm	DC6-36V	NPN	NO	Flush	50Hz
CM30-3010NB	0-10mm	DC6-36V	NPN	NC	Flush	50Hz
CM30-3010NC	0-10mm	DC6-36V	NPN	NO+NC	Flush	50Hz
CM30-3010PA	0-10mm	DC6-36V	PNP	NO	Flush	50Hz
CM30-3010PB	0-10mm	DC6-36V	PNP	NC	Flush	50Hz
CM30-3010PC	0-10mm	DC6-36V	PNP	NO+NC	Flush	50Hz
CM30-2010A	0-10mm	AC90-250V	SCR	NO	Flush	10Hz
CM30-2010B	0-10mm	AC90-250V	SCR	NC	Flush	10Hz
CM30-3015NA	0-15mm	DC6-36V	NPN	NO	Non-flush	50Hz
CM30-3015NB	0-15mm	DC6-36V	NPN	NC	Non-flush	50Hz
CM30-3015NC	0-15mm	DC6-36V	NPN	NO+NC	Non-flush	50Hz
CM30-3015PA	0-15mm	DC6-36V	PNP	NO	Non-flush	50Hz
CM30-3015PB	0-15mm	DC6-36V	PNP	NC	Non-flush	50Hz
CM30-3015PC	0-15mm	DC6-36V	PNP	NO+NC	Non-flush	50Hz
CM30-2015A	0-15mm	AC90-250V	SCR	NO	Non-flush	10Hz
CM30-2015B	0-15mm	AC90-250V	SCR	NC	Non-flush	10Hz

Item Code		LR30		LR30	
Mounting		● Flushed	◐ Non-flushed	● Flushed	◐ Non-flushed
Sensing distance		10mm	15mm	10mm	15mm
Output	DC 2 Wires NO	LR30BF10DLO	LR30BN15DLO	LR30BF10DLO-E2	LR30BN15DLO-E2
	DC 2 Wires NC	LR30BF10DLC	LR30BN15DLC	LR30BF10DLC-E2	LR30BN15DLC-E2



Technical Parameter					
Supply voltage		10...30 VDC	10...30 VDC	10...30 VDC	10...30 VDC
Temperature drift		< ±10%	< ±10%	< ±10%	< ±10%
Load current		<100mA	<100mA	<100mA	<100mA
Voltage drop		<6V	<6V	<6V	<6V
Leakage current		<1mA	<1mA	<1mA	<1mA
Hysteresis		1...20%	1...20%	1...20%	1...20%
Repeat accuracy		<3%	<3%	<3%	<3%
Frequency		300Hz	200Hz	300Hz	200Hz
Output indicator		Yellow LED	Yellow LED	Yellow LED	Yellow LED
Polarity protection		yes	yes	yes	yes
Surge protection		yes	yes	yes	yes
Short-circuit protection	
Ambient temperature		-25...+70°C	-25...+70°C	-25...+70°C	-25...+70°C
Ambient moisture		35...95%	35...95%	35...95%	35...95%
Protection degree		IP67	IP67	IP67	IP67
Housing material		Nickel-copper Alloy	Nickel-copper Alloy	Nickel-copper Alloy	Nickel-copper Alloy
Connection		2m PVC Cable	2m PVC Cable	M12 Connector	M12 Connector
Certification		CE U _L	CE U _L	CE U _L	CE U _L

* Cable material and length can be customized

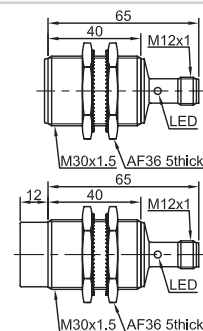
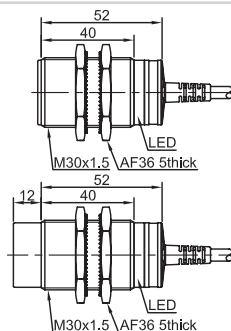


Item Code		LR30		LR30		
Mounting		● Flushed	◐ Non-flushed	● Flushed	◐ Non-flushed	
Sensing distance		10mm	15mm	10mm	15mm	
Output		DC 2 Wires NO	LR30BF10ELO	LR30BN15ELO	LR30BF10ELO-E2	LR30BN15ELO-E2
		DC 2 Wires NC	LR30BF10ELC	LR30BN15ELC	LR30BF10ELC-E2	LR30BN15ELC-E2



Technical Parameter				
Supply voltage	10...60 VDC	10...60 VDC	10...60 VDC	10...60 VDC
Temperature drift	< ±10%	< ±10%	< ±10%	< ±10%
Load current	<100mA	<100mA	<100mA	<100mA
Voltage drop	<6V	<6V	<6V	<6V
Leakage current	<1mA	<1mA	<1mA	<1mA
Hysteresis	1...20%	1...20%	1...20%	1...20%
Repeat accuracy	<3%	<3%	<3%	<3%
Frequency	300Hz	200Hz	300Hz	200Hz
Output indicator	Yellow LED	Yellow LED	Yellow LED	Yellow LED
Polarity protection	yes	yes	yes	yes
Surge protection	yes	yes	yes	yes
Short-circuit protection
Ambient temperature	-25...+70°C	-25...+70°C	-25...+70°C	-25...+70°C
Ambient moisture	35...95%	35...95%	35...95%	35...95%
Protection degree	IP67	IP67	IP67	IP67
Housing material	Nickel-copper Alloy	Nickel-copper Alloy	Nickel-copper Alloy	Nickel-copper Alloy
Connection	2m PVC Cable	2m PVC Cable	M12 Connector	M12 Connector
Certification	CE U _L	CE U _L	CE U _L	CE U _L

* Cable material and length can be customized



SPECIFICATIONS

1. THIS SPECIFICATIONS APPLY TO RSA0N1211 POTENTIOMETERS.

2. CONTENTS OF THIS SPECIFICATIONS.

4SA02R-003
4S0001-200M
4S0001-202M
SA02RG102

3. MARKING

• MARKING ON ALL UNITS
DATE CODE, RESIST. VALUE, TAPER, TRADE MARK

4. REMARKS

• NOTES

• Marking ⇒ in specifications shows standard and condition for application.

CLASS.NO.

TITLE

HASTER TYPE POTENTIOMETER(SLIDE)

1. Environment 一般事項

1.1 Operating temperature range 使用温度範囲 -10-60°C

1.2 Storage temperature range 保存温度範囲 -30-70°C

1.3 Test conditions 試験条件

Unless otherwise specified, the standard range of atmospheric conditions for making measurements and test is as follows.

Ambient temperature: 5°C to 35°C
 Relative humidity : 45% to 85%
 Air pressure : 860mbar to 1060 mbar.

If there is any doubt about the results, measurements shall be made within the following limits.

Ambient temperature: 20±2°C
 Relative humidity : 60 to 70%
 Air pressure : 860mbar to 1060mbar.

試験及び測定は特に規定がない限り温度5-35°C、相対湿度45-85%、気圧860-1060mbarの標準状態のもとで行う。

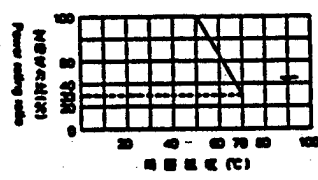
ただし、判定に疑義を生じた場合は温度20±2°C、相対湿度65±5%、気圧860-1060mbarにて行う。

2. Appearance 外観

The potentiometer shall be well done and not have any excessive rust, crack, split, poor plating and discolor in any portion.

各部の仕上げは良好で機械上有害なサビ、キズ、ワレ、メッキ不良及び剥離などがあってはならない。

3. Electrical characteristics 電気的仕様

Item 項目	Conditions 条件	Specifications 規格				
		5	10	20	50	100
3.1 Nominal total resistance and tolerance 公称全抵抗値および許容差	Measurement shall be made by the resistance between terminal 1 and 3 with lever set at terminal 1 or 3. レバーを端子1又は、3の終端におき、抵抗器の端子1-3間の抵抗値を測定する。	200	250	500	±20%	
3.2 Power rating 定格電力	Power rating is based on continuous full load operation at the maximum voltage between terminals 1 and 3. Power rating vs. ambient temperature shall be denoted on the following graph. 端子1と3の間に連続負荷することができる最大電力。周囲温度に対する電力軽減曲線は右図とする。 	0.25W				
3.3 Rated voltage 定格電圧	Rated voltage $E = \sqrt{PR}$ (V) P: Power rating 定格電力(W) R: Nominal total resistance 公称全抵抗値(Ω) When the rated voltage exceeds the maximum operating voltage, the maximum operating voltage shall be the rated voltage. ただし、定格電圧が最高使用電圧を越える場合は、この最高使用電圧を定格電圧とする。	Maximum operating voltage 最高使用電圧			DC 10V AC 350V	
3.4 Resistance law (Taper) 抵抗変化特性	Measurement shall be made by the resistance law method, 電圧法にて測定 Measurement shall be made at the position of right diagram from the edge at the side of terminal 1. When based on terminal 3, from the edge at the side of terminal 3. Output voltage between terminals 1 and 2 / Applied voltage between terminals 1 and 3 × 100(%) $\frac{1-2 \text{端子間出力電圧}}{1-3 \text{端子間印加電圧}} \times 100(\%)$ Output voltage between terminals 1 and 2 / Applied voltage between terminals 1 and 3 (dB) $20 \log \frac{1-2 \text{端子間出力電圧}}{1-3 \text{端子間印加電圧}} (\text{dB})$	Resistance law (Taper) 抵抗変化特性 A, B, C D, K,			Refer to page 5/5 6/6 5/5ページ参照	


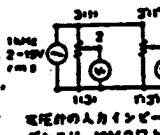
ALPS ELECTRIC CO., LTD.

SYMB.	DATE	APPD.	CHKD.	DSGD.	TITLE
△1	Aug 892	Y.Y			SPECIFICATIONS
					DOCUMENT NO.
					4SA02R-003 (1/6)

CLASS.NO.

TITLE

MASTER TYPE POTENTIOMETER(SLIDE)

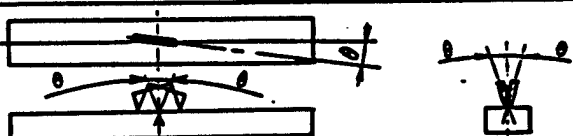
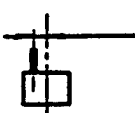
Item 項目	Conditions 条件	Specifications 規格								
<p>3.5 Attenuation and insertion loss 最大減衰量と挿入損失</p>	<p>The attenuation and insertion loss at each end of lever travel shall be measured. レバー動子を移動距離の各終端に置いたとき 最大減衰量、挿入損失を測定する。</p> <p>The voltage of 2 Vr.m.s. to 15 Vr.m.s. shall be applied between terminal 1 and 3 by measuring frequency at 1 kHz. The output voltage shall be measured between terminals 1 and 2 and between terminals 2 and 3. If there is not any doubt about the results, DC voltage shall be used as the test voltage. 端子1-3間に1kHzで2-15V (正弦波実効値)の電圧を加え、端子1-2間、端子2-3間の出力電圧を測定する。なお、判定に疑義が生じなければ、試験電圧として直流を用いてもよい。</p>  <p>電圧計の入力インピーダンスは、10MΩ以上 Input impedance of the voltmeter: 10MΩ or more</p>	<p>Nominal total resistance 公称全抵抗値 (kΩ)</p> <table border="1"> <tr> <td>5 ≤ Ra ≤ 10</td> <td>70</td> </tr> <tr> <td>10 < Ra ≤ 50</td> <td>80</td> </tr> <tr> <td>50 < Ra ≤ 100</td> <td>90</td> </tr> <tr> <td>100 < Ra ≤ 500</td> <td>100</td> </tr> </table> <p>Attenuation 最大減衰量 (dB 以上)</p>	5 ≤ Ra ≤ 10	70	10 < Ra ≤ 50	80	50 < Ra ≤ 100	90	100 < Ra ≤ 500	100
		5 ≤ Ra ≤ 10	70							
		10 < Ra ≤ 50	80							
		50 < Ra ≤ 100	90							
		100 < Ra ≤ 500	100							
<p>3.6 Noise レバー動雑音</p>	<p>DC 20V, when the rated voltage is 20V or less, its rated voltage shall be applied to the terminals between 1 and 3. And then the noise shall be measured by the specified speed. For other procedures, refer to IEC Pub. 393-1-8. Test Method B. Traveling speed: 20mm/sec 端子1-3間に直流電圧20V (定格が20V以下の時は、その電圧)を加え、レバーを20mm/秒の速さで移動させ、このときに発生する雑音電圧を測定する。その他 JIS C 5261A 法による。</p>	<p>Nominal total resistance 公称全抵抗値 (kΩ)</p> <table border="1"> <tr> <td>5 ≤ Ra ≤ 50</td> <td>47</td> </tr> <tr> <td>50 < Ra ≤ 500</td> <td>85</td> </tr> </table> <p>(mVP-P) 未測</p>	5 ≤ Ra ≤ 50	47	50 < Ra ≤ 500	85				
		5 ≤ Ra ≤ 50	47							
50 < Ra ≤ 500	85									
<p>3.7 Insulation resistance 絶縁抵抗</p>	<p>A voltage of 250V DC shall be applied for 1 min., after which measurement shall be made. D.C. 250Vの電圧を印加して測定。(1分間)</p>	<p>Between individual terminals and frame/lever Between adjacent terminals 端子-レバー間 端子-枠間 独立した抵抗素子の端子間</p> <p>100MΩ or more 以上</p>								
<p>3.8 Dielectric strength 耐電圧</p>	<p>Trip current: 2mA Measuring frequency: 50/60Hz 250V AC for 1 min. A.C. 250V r.m.s. 1分間。 感度電流 2mA (周波数 50/60Hz)</p>	<p>Between individual terminals and frame/lever Between adjacent terminals</p> <p>Without damage to parts, arcing or breakdown etc. 損傷、アークおよび絶縁破壊を生じないこと。</p>								
<p>3.9 Tracking error 相互偏差</p>	<p>The voltage of 2 Vr.m.s. to 15 Vr.m.s. shall be applied between terminals 1 and 3 and between terminals 1 to 3' by measuring frequency at 1 kHz. The output voltage shall be measured between terminals 1 and 2 (for the C and RD taper, the measurement shall be made between terminals 2 and 3 and between terminals 2' and 3') units the first of these shall be the standard one. If there is not any doubt about the results, DC voltage shall be used as the test voltage. 端子1-3間、端子1'-3'間にそれぞれ1kHzで2-15V (正弦波実効値)の電圧を加え、前段を基準として端子1-2間、端子1'-2'間(3端子基準の場合は、端子2-3間、端子2'-3'間)の出力電圧を測定する。なお、判定に疑義が生じなければ、試験電圧として直流を用いてもよい。</p>  <p>電圧計の入力インピーダンスは、10MΩ以上 Input impedance of the voltmeter: 10MΩ or more</p>	<p>At 50% of lever travel 移動距離の50%の位置</p> <table border="1"> <tr> <td>± _ dB</td> </tr> <tr> <td>± 3 dB</td> </tr> <tr> <td>± dB</td> </tr> <tr> <td>± dB</td> </tr> </table>	± _ dB	± 3 dB	± dB	± dB				
± _ dB										
± 3 dB										
± dB										
± dB										



ALPS ELECTRIC CO., LTD.

APPD.	CHKD.	DSGD.	TITLE
Sep. 12 '91	Sep. 11 '91	Sep. 9 '91	SPECIFICATIONS
Y. Yoshida	G. Aho	M. Nishimura	DOCUMENT NO.
			4SA02R-003 (2/6)

4. Mechanical characteristics 機械的性能

Item 項目	Conditions 条件	Specifications 規格
4.1 Lever travel レバー 移動距離		100±1mm
4.2 Operating force 作動力	Traveling speed: 20mm/sec Operating position: Tip of the lever 移動速度は20mm/秒とする。 操作位置はレバー先端部とする。	80gf±50gf
	Starting force 始動力	Traveling speed: 20mm/sec Operating position: Tip of the lever 移動速度は20mm/秒とする。 操作位置はレバー先端部とする。 作動力+100gf以下
4.3 Lever travel stop strength レバーの移動 止強度	A static load of 10Kgf shall be applied at the point 5mm from top surface of the case for both ends in the direction of lever travel for 10sec. しゅう動距離の両末端において、枠上面より5mmの位置に10Kgfの静荷重を10秒間加える。	Without excessive play or poor contact 著しいガタ、および接触不良を生じないこと。
4.4 Side thrust of the lever レバーの横押し強度	A static load of 2Kgf shall be applied at the point 5mm from top surface of the case in a direction perpendicular to the axial direction for 10sec., with the potentiometer mounted in assembly conditions. 本体をシャーシに固定し、枠上面より5mmの位置にレバー移動方向に対して直角方向に2Kgfの静荷重を10秒間加える。	Without deformation or breaks in the sliding part and contact part. 操作部および側導部に変形、破損がないこと。
4.5 Thrust and tensile lever レバーの押し引き強度	Thrust and tensile static load of 5 kgf shall be applied to the potentiometer in the lever direction for 10 sec. レバーの押し方向および引張り方向に5kgfの静荷重を10秒間加える。	Without damage such as bad sliding and braking or play in the lever. Electrical characteristics shall be satisfied. レバーのガタ、および破損、しゅう動ムラ等がなく、電気的性能を満足すること。
4.6 Displacement of lever レバーの横揺れ	A torsion moment of 250gf.cm shall be applied at the lever in a direction perpendicular to the axial direction and then the displacement shall be measured. レバーに250gf.cmの曲げモーメントを移動方向に対して直角に加えレバー先端で測定する。	or less 2(L/25)mm-P 以下 L=Length of lever レバー長さ
4.7 Lever inclination and torsion レバーの傾きおよびねじれ		θ shall be 2° or less. Return to the same position after torsion. θは2度以下。また、ひねりを加えた時、元に戻ること。
4.8 Distance from the center of the lever レバーのセンターズレ	After sliding lever as far as it will go in each direction, the distance from the center of the lever to the middle of the mounting screw hole shall be measured at the both ends. 取付けネジ穴中心に対するレバーのセンターからのずれを片側ごとに測定する。 	0.5mm or less on each end. 片側0.5mm以下。
4.9 Resistance to soldering heat はんだ耐熱	BR temperature: 350°C or less Application time of soldering iron: 5 sec or less 温度350°C以下。時間5秒以内。 ただし、端子に異常加圧のないこと。	Change in total resistance is relative to the value before test: 5% Without excessive looseness of terminals and failure contact. 全抵抗値の変化は初期値の±5%以内。 著しいガタ、接触不良を生じない。

ALPS ALPS ELECTRIC CO., LTD.

APPD.	CHKD.	DSGD.	TITLE
<i>Sep. 12 '91</i>	<i>Sep. 11 '91</i>	<i>Sep. 9 '91</i>	SPECIFICATIONS
SYMB. DATE APPD. CHKD. DSGD.			DOCUMENT NO.
			4SA02R-003 (3/6)

5. Endurance 耐久性能

	Item 項目	Conditions 条件	Specifications 規格															
5.1	Endurance without load 無負荷しゅう動寿命	The moving contact, without electrical load, shall be slid from one end stop to the other and returned to its original position extended over 90% or more effective distance. This procedure constitutes 1 cycle. And the moving contact shall be subjected to 600 cycles per hour, a total of 30000 ±200 cycles (5,000 to 8,000 continuous cycles for 24 hours.) 無負荷にてレバーを600サイクル/時の速さで有効移動距離の90%以上にわたり、1日連続5000-8000サイクル、合計30000±200サイクル移動させる。	Change in total resistance is relative to the value before test: ±15% Noise: Refer to Note 1) Operating force: 10-200gf Clause (3), (4) shall be satisfied. 全抵抗値の変化は初期値の±15%以内しゅう動雑音は注記 1)による。 作動力 10-200gf その他は、(3項)(4項)を満足すること。															
5.2	Cold 耐寒性	The potentiometer shall be stored at a temperature of -30±2°C for 96 hours in a thermostatic chamber. Then the potentiometer shall be taken out of the chamber and its surface moisture shall be removed. And then the potentiometer shall be subjected to standard atmospheric conditions for 1 hour, after which measurement shall be made. -30±2°Cの恒温槽中にて96時間放置し、常温常温中に1時間放置後1時間以内に測定する。 ただし水滴は、取り除くものとする。	Change in total resistance is relative to the value before test: ±20% Clause (3) (4) shall be satisfied. 全抵抗値の変化は初期値の±20%以内その他は、(3項)(4項)を満足すること。															
5.3	Dry heat 耐熱性	The potentiometer shall be stored at a temperature of 70±2°C for 240±8 hours in a thermostatic chamber. Then the potentiometer shall be maintained at standard atmospheric conditions for 1 hour, after which measurements shall be made. 70±2°Cの恒温槽中にて240±8時間放置し、常温常温中に1時間放置後1時間以内に測定する。	Change in total resistance is relative to the value before test: +5 -30%. Noise: Refer to Note 1) Operating force: 10-200gf Clause (3) (4) shall be satisfied. 全抵抗値の変化は初期値の+5--30%以内しゅう動雑音は注記 1)による。 作動力 10-200gf その他は、(3項)(4項)を満足すること。															
5.4	Damp heat 耐湿性	The potentiometer shall be stored at a temperature of 40±2°C with relative humidity of 90% to 95% for 96±4 hours in a thermostatic chamber. And its surface moisture shall be removed. And then the potentiometer shall be subjected to standard atmospheric conditions for 1 hour, after which measurement shall be made. 40±2°C相対湿度90-95%の恒温湿度槽中にて96±4時間放置し、常温常温中に1時間放置後1時間以内に測定する。 ただし水滴は、取り除くものとする。	Change in total resistance is relative to the value before test: +35 -5%. Noise: Refer to Note 1) Operating force: 10-200gf Clause (3) (4) shall be satisfied. 全抵抗値の変化は初期値の+35--5%以内しゅう動雑音は注記 1)による。 作動力 10-200gf その他は、(3項)(4項)を満足すること。															
5.5	Change of temperature 温度サイクル	The potentiometer shall be subjected to 5 successive change of temperature cycles, each as shown in table below. Then its surface moisture shall be removed. And then the potentiometer shall be subjected to standard atmospheric conditions for 1 hour, after which measurements shall be made. 下記条件で5サイクル試験後、常温常温中に1時間放置後1時間以内に測定する。ただし水滴は、取り除くものとする。 <table border="1" style="margin: 10px auto; border-collapse: collapse;"> <thead> <tr> <th>Order 順</th> <th>Temperature 温度</th> <th>Duration 時間</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>-10±3°C</td> <td>30 Min, 30分</td> </tr> <tr> <td>2</td> <td>Standard atmospheric conditions 常温</td> <td>10-15 Min, 10-15分</td> </tr> <tr> <td>3</td> <td>70±2°C</td> <td>30 Min, 30分</td> </tr> <tr> <td>4</td> <td>Standard atmospheric conditions 常温</td> <td>10-15 Min, 10-15分</td> </tr> </tbody> </table>	Order 順	Temperature 温度	Duration 時間	1	-10±3°C	30 Min, 30分	2	Standard atmospheric conditions 常温	10-15 Min, 10-15分	3	70±2°C	30 Min, 30分	4	Standard atmospheric conditions 常温	10-15 Min, 10-15分	Change in total resistance is relative to the value before test: ±20% Noise: Refer to Note 1) Operating force: 10-200gf Clause (3) (4) shall be satisfied. 全抵抗値の変化は初期値の±20%以内しゅう動雑音は注記 1)による。 作動力 10-200gf その他は、(3項)(4項)を満足すること。
Order 順	Temperature 温度	Duration 時間																
1	-10±3°C	30 Min, 30分																
2	Standard atmospheric conditions 常温	10-15 Min, 10-15分																
3	70±2°C	30 Min, 30分																
4	Standard atmospheric conditions 常温	10-15 Min, 10-15分																

ALPS ELECTRIC CO., LTD.					
		APPD.	CHKD.	DSGD.	TITLE SPECIFICATIONS
		<i>Sep. 10 '91</i>	<i>Sep. 11 '91</i>	<i>Sep. 9 '91</i>	DOCUMENT NO.
		<i>Y. Yoshida</i>	<i>S. Aho</i>	<i>M. Morisawa</i>	4SA02R-003 (4/6)
SYMB.	DATE	APPD.	CHKD.	DSGD.	

CLASS.NO.	TITLE
	MASTER TYPE POTENTIOMETER(SLIDE)

Note 1) For noise specification after the test, refer to the list below.

注記 1) 試験後のしゅう動雑音規格は、下表による。

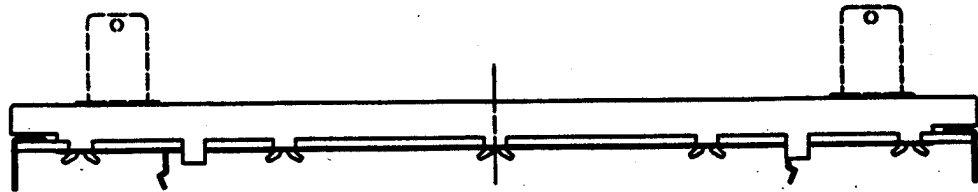
Nominal total resistance 公称全抵抗値 (KΩ) $5 \leq R_a \leq 50$	Nominal total resistance 公称全抵抗値 (KΩ) $50 < R_a \leq 500$
Less than 150mVP-P 未満	Less than 300mVP-P 未満

2) Measurement of the endurance characteristic shall be made after 5 cycles' slide of moving contact

2) 耐久性能後の測定は、レバーを5サイクルしゅう動後とする。

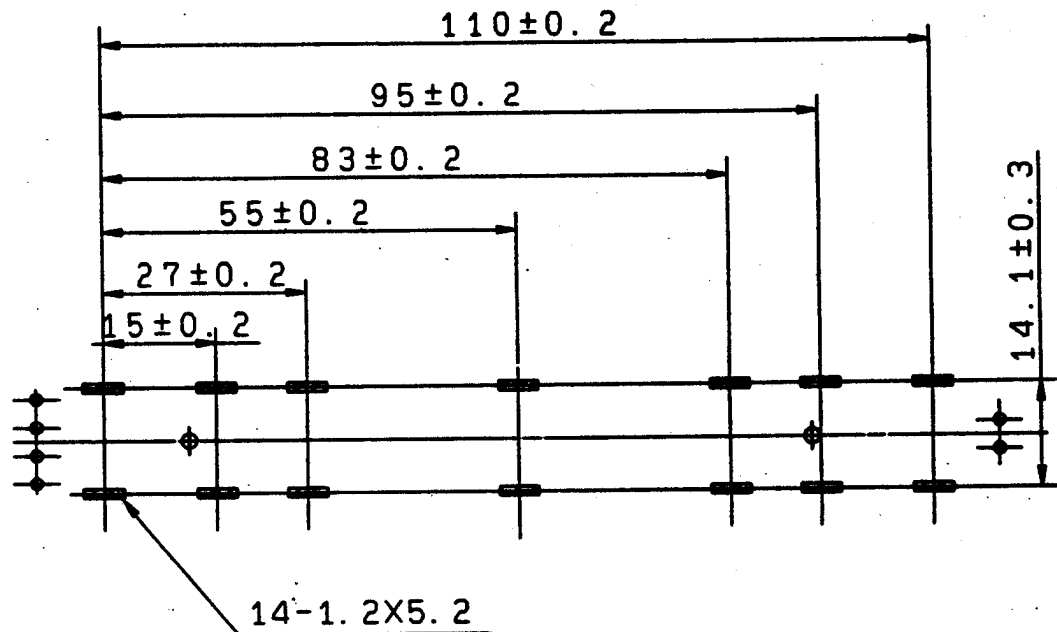
△ 3) Prohibition of patten wiring for oblique line department.

3) 斜線部は、パターン配線を禁止します。



Viewed from mounting side

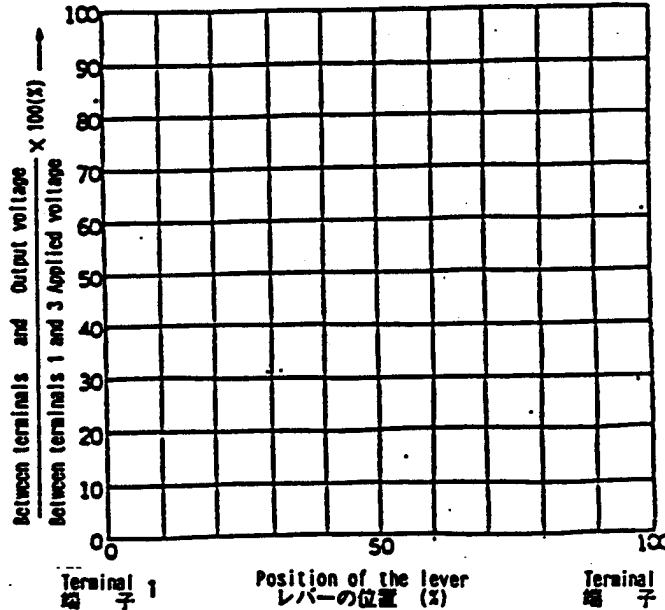
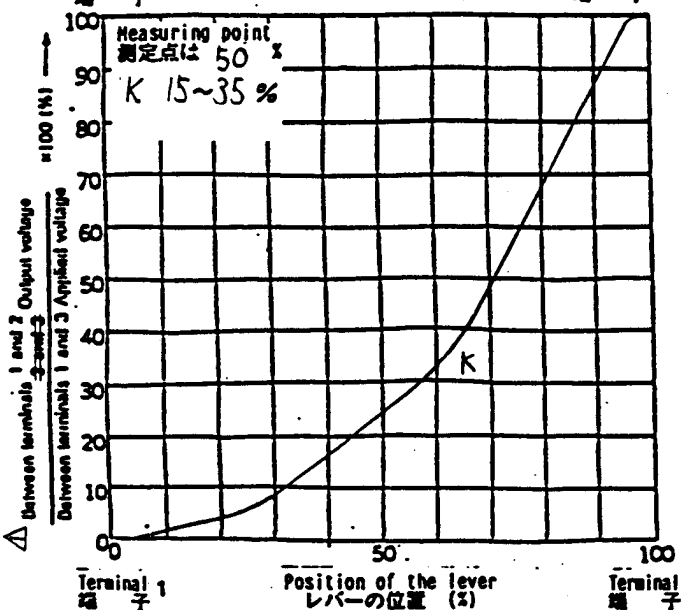
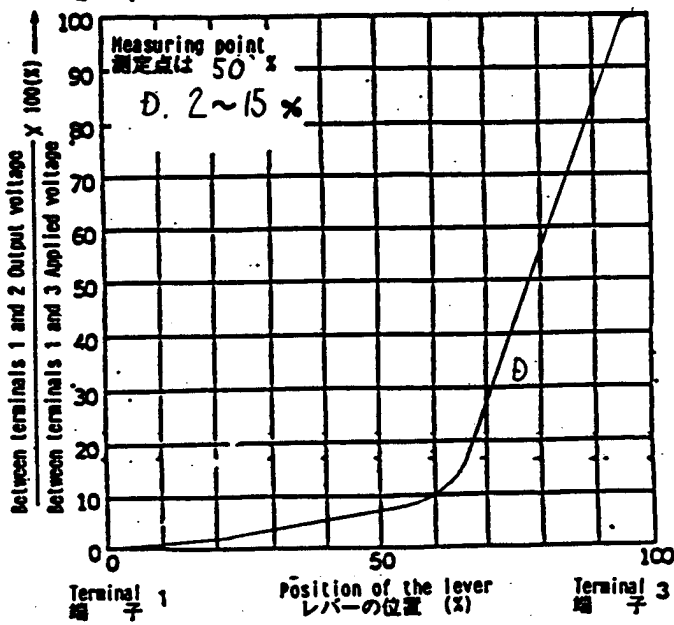
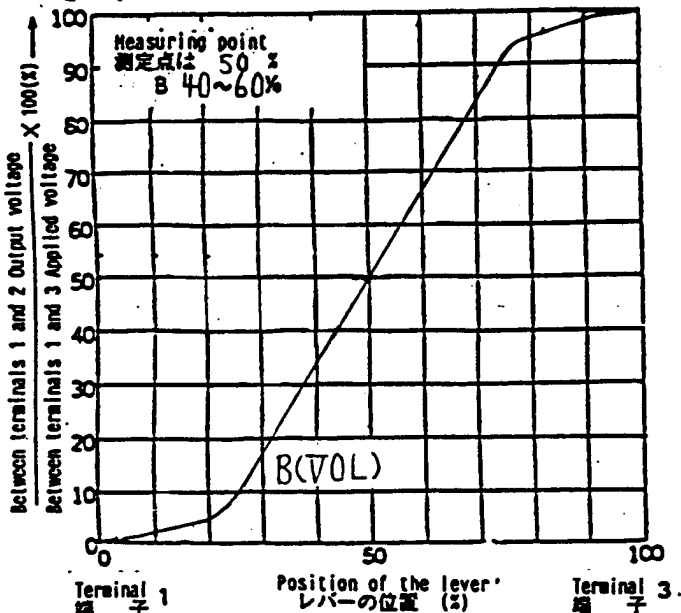
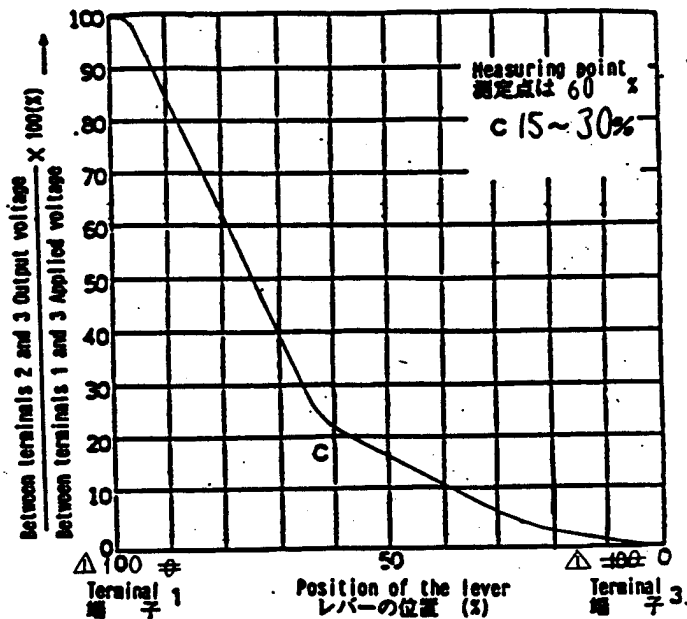
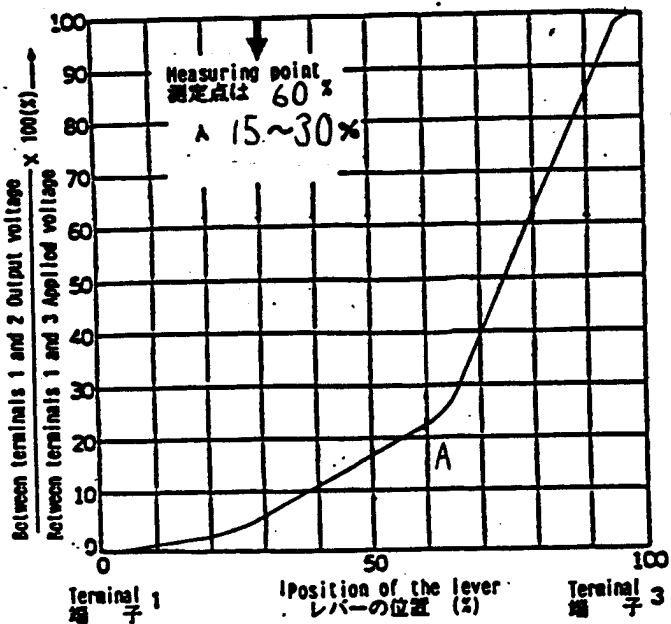
挿入側より



Unit : mm

					ALPS ELECTRIC CO., LTD.	
					APPD.	CHKD.
					Apr. 17 '92	
					DSGD.	TITLE
					Apr. 17 '92	SPECIFICATIONS
					DOCUMENT NO.	
					4SA02R-003 (5/6)	
△ 1	Feb. 10 '92	Y.Y	G.O	M.S		
SYMB	DATE	APPD.	CHKD.	DSGD.		

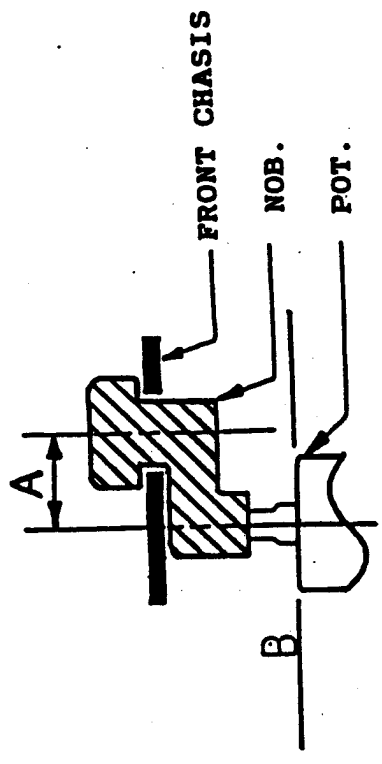
RESISTANCE LAW (TAPER) 抵抗変化特性規格



				APPD.	CHKD.	DSGD.	TITLE
				Sep. 6 '91	Sep. 6 '91	Sep. 6 '91	SPECIFICATIONS
3	Aug. 8 '91	Y.Y.		M. Inoue	M. Matsubara	T. Kamagata	DOCUMENT NO.
SYN3	DATE	APPD.	CHKD.	DSGD.			4SA02R-003 (6/6)

PRECAUTION IN USE

- 1. If it will be used the operating point away from the center line of the lever, it should be shorter as possible.
- 2. About the length of lever
If conditions permit, it is advisable to use the shortest possible lever. The longer the length up to operating point, the more unfavorable slide feeling will be given.



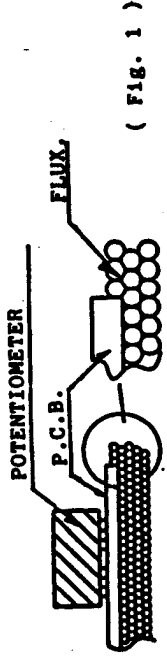
3. Regarding the operation of the lever, please consider the above mentioned, and make sure nothing is wrong with the operation under installing in your appliance that you plan to use our products actually.

		ALPS ELECTRIC CO., LTD.		
APPD.	CHKD.	DSCD.		
Aug. 10 '91	Aug. 9 '91	Aug. 9 '91	TITLE	
			SLIDE POTENTIOMETER	
			DOCUMENT NO.	
			4S0001-200M	
DATE	APPR.	CHKD.	DECD.	

V. Morioka
G. Obe

FOLLOW THE NEXT CONDITIONS FOR SOLDERING

1. Solder
63 % Sn solder specified in JIS Z3282.
2. Board in Use
Single-face copper laid laminate board.
Plate thickness (t) = 1.6 mm
3. In the Case of Dip Soldering
 - (1) State of potentiometer
Position a lever in the vicinity of center.
 - (2) Specific Gravity of Flux
0.83±0.01 (foaming type)
 - (3) Height of Flux face
A level of the upper face of flux for reaching the position at a half of the plate thickness of printed board. (Fig.1)
Further, no flow of flux invading on the surface of printed board on the side of installing potentiometer is allowed.



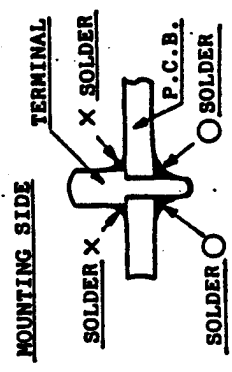
(Fig. 1)

- (4) Preheat Condition
100°C MAX., within 1 minute
(Temperature on the side of installing printed board is designated.)
- (5) Soldering Condition
Solder temperature; 260°C MAX.
Soldering period ; within 5 seconds
Time of soldering ; only one time is permitted

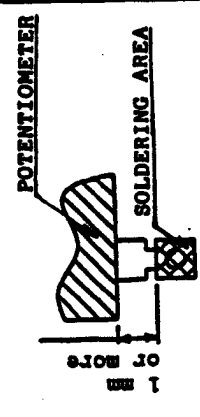
4. In the Case of Manual Soldering
Solder temperature ; 300°C MAX.
Soldering period ; within 3 seconds
Time of soldering ; only one time is permitted

5. Matters to Be Noted

- (1) Do not add any stress on terminals in the case of soldering.
For instance, forced movement of potentiometer with terminals being heated may probably deteriorate the electric features due to generation of looseness in connection between resistant board and terminals.
- (2) Use caution to soldering process so as to prevent solder from rising up to the surface of printed board on the side of installing potentiometer, because defective contact may take place in terminal connecting part due to soldering heat (Fig. 2)
- (3) In the case of lead wiring, solder it so that a gap of 1 mm or more may be reserved between the potentiometer body and soldering part. (Fig. 3)
- (4) The grade of influence of soldering exerted on the potentiometer depends upon the size of a printed board, installing position of the potentiometer, and the size of a solder bath etc. Therefore, make sure, in advance, of no abnormal state under the conditions of soldering to be carried out at present.



(Fig. 2)

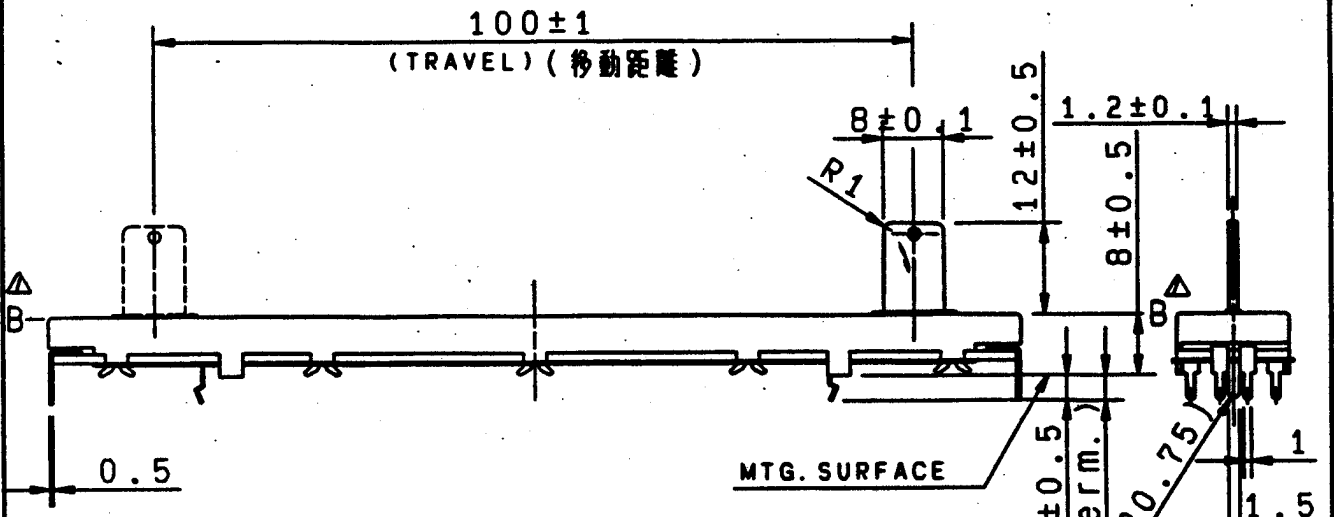
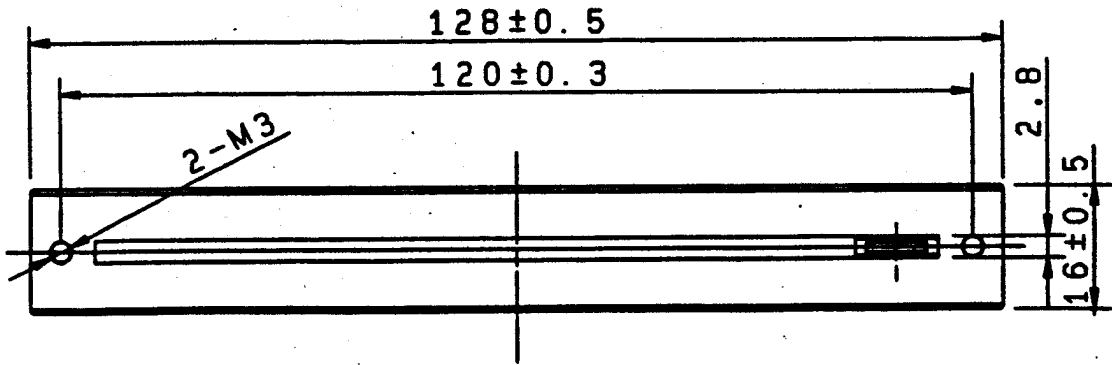


(Fig. 3)

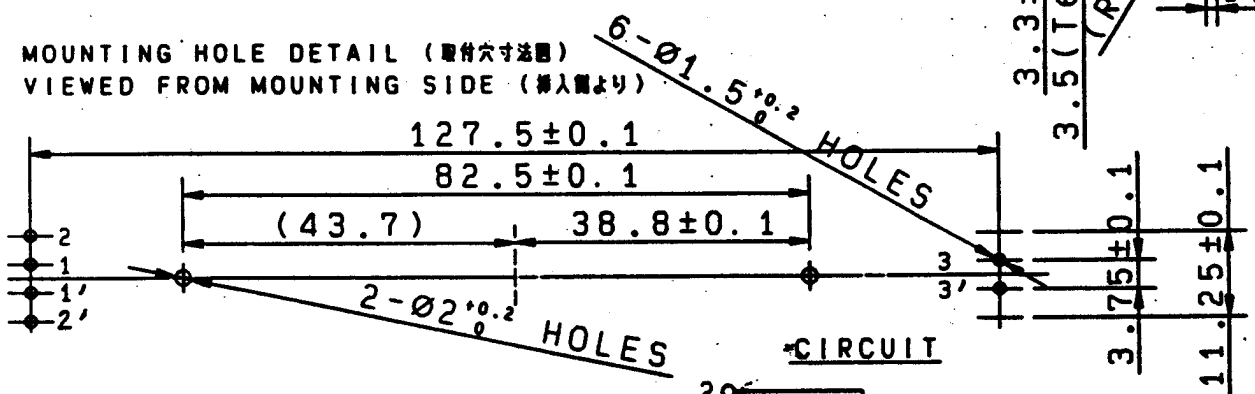
SYMR		DATE	APPD.	CHKD.	DSGD.	TITLE	
						SLIDE POTENTIOMETER	
						DOCUMENT NO.	
						4S0001 - 202M	

ALPS ELECTRIC CO., LTD.

APPD. *Sep 9 91*
 CHKD. *Sep 9 91*
 DSGD. *Sep 6 91*
 S. Aho.
 M. Sato



MOUNTING HOLE DETAIL (取付穴寸法図)
VIEWED FROM MOUNTING SIDE (挿入側より)



NOTE 1. MOUNTING SCREW THREAD LENGTH IS CHASSIS THICKNESS+3mm MAX.
 △ 2. Within 30mm from B included knob's height.
 注記 1. 取付ネジの首下長さはシャーシ板厚+3mm以下とする。
 △ 2. レバーの長さは、ツマミも含めて30mm以内にてご使用願います。

指定なき部分の許容差 TOLERANCES UNLESS OTHERWISE SPEC	
$L \leq 10$	± 0.3
$10 < L \leq 100$	± 0.5
$100 < L$	± 0.8
角度 ANGULAR DIMENSION	$\pm 5^\circ$

PART NO.	NAME	MATERIAL NAME / CODE	FINISH
		ALPS ALPS ELECTRIC CO., LTD.	
		DSGD. 27743	SCALE 1 : 1
		S. ABE 90-07-24	SA02RG102
		CHKD.	FIGURE 100mm SLIDE POTENTIOMETER DUAL UNIT 28271F891-4
△ 4	Jan. 17 '92	G.A.	UNIT M M RSA0N1
SYMB	DATE	APPD CHKD DSGD	2. 1. 22
		J. Asadap 90-07-24	UL 29

①-12L
プリント
2連

OR

HM8143

Three-Channel Arbitrary Power Supply

HAMEG[®]
Instruments
A Rohde & Schwarz Company



Key facts

- ▮ 2x 0V to 30V / 1x 5V, 3x 2A (130W)
- ▮ Linear regulated, two-quadrant power supply (current source and sink)
- ▮ Realtime voltage and current values
- ▮ Advanced parallel and serial operation
- ▮ Setting and readback resolution: 10mV, 1mA
- ▮ Electronic fuse and tracking mode
- ▮ Front connectors: 4mm (0.16 in) safety sockets
- ▮ SENSE connectors for line loss compensation (30V channels)
- ▮ External modulation of output voltages up to 50kHz
- ▮ Arbitrary module: 4,096 points, 12 bit
- ▮ RS-232/USB dual interface, IEEE-488 (GPIB) optionally

Test & Measurement

Technical Data

Specifications

HM8143

Three-Channel Arbitrary Power Supply

from firmware version 2.45

Electrical Specifications

Total power output	130W
Number of outputs	3
Front connectors	4 mm safety sockets
Maximum power per channel	
CH1, CH3	60W
CH2	10W
Voltage output	
CH1, CH3	0V to 30V
CH2	5V (± 50 mV)
Current output	
all channels	max 2A
Current sinking	
CH1, CH3	max 2A
Line & load regulation	
Constant voltage mode	
CH1, CH3	$<0.02\% + 5$ mV
CH2	$<0.25\% + 10$ mV
Constant current mode	
CH1, CH3	$<0.02\% + 5$ mA
CH2	(no constant current mode)
Voltage ripple 3 Hz to 300 kHz (front connectors)	
CH1, CH3	<5 mV _{rms}
CH2	<1 mV _{rms}
Transient response time (10% to 90% load change)	
CH1, CH3	<45 μ s in a band of ± 20 mV of V_{set} max. deviation: <800 mV
CH2	<45 μ s in a band of ± 20 mV of V_{set} max. deviation: <200 mV
SENSE connectors available for	CH1, CH3
Max. SENSE compensation	300 mV
Programming accuracy (23°C $\pm 5^\circ$ C)	
Voltage / Current	
CH1, CH3	± 3 digits (typ. ± 2 digits)
Readback accuracy (23°C $\pm 5^\circ$ C)	
Voltage / Current	
CH1, CH3	± 3 digits (typ. ± 2 digits)
Resolution	
Voltage	
CH1, CH3	10 mV
Current	
CH1, CH3	1 mA
Voltage to earth	max. 150 V _{DC}
Over current protection (electronic fuse)	Yes

Modulation Input (CH1, CH3)

Rear connectors	2x BNC
Input level	0V to 10V
Accuracy	1% of full scale
Modulation bandwidth	DC to 50 kHz
Slew rate (dV/dt)	1 V/ μ s

Trigger Input (BNC)

Function	Triggering the arbitrary function
Trigger level	TTL
Edge direction	rising, falling

Arbitrary Function (CH1)

Parameter	Voltage, dwell time
Number of Points	max. 4,096
Dwell time	100 μ s to 60s
Repetition rate	continuous or burst mode with 1 to 255 repetitions
Resolution	12 Bit
Trigger	interface, trigger input

Remote Interfaces

Standard	Dual interface RS-232 / USB (HO820)
Optional	IEEE-488 (GPIB) interface (HO880)

Miscellaneous

Input power option	115 V _{AC} / 230 V _{AC} ($\pm 10\%$), 50 Hz to 60 Hz, CAT II
Power consumption	300 VA
Mains fuses	
115 V _{AC}	2x 6 A, slow blow (5 mm x 20 mm)
230 V _{AC}	2x 3.15 A, slow blow (5 mm x 20 mm)
Operating temperature	+5°C to +40°C
Storage temperature	-20°C to +70°C
Humidity	5% to 80%
Display	4x 4 digits, 7-segment LEDs
Dimensions (H x W x D)	75 x 285 x 365 mm
Rack mount capability (19" rack mount kit, 2RU)	Yes (HZ42)
Weight	9 kg

The specifications are based on a 30 min warm-up period.

Accessories included:

Line cord, operating manual, software-CD

Recommended accessories:

HZ42	19" rackmount kit, 2 RU
HZ10S	5 x silicon test lead (black)
HZ10R	5 x silicon test lead (red)
HZ10B	5 x silicon test lead (blue)
HO880	IEEE-488 (GPIB) interface card
HZ72	IEEE-488 (GPIB) interface cable, 2 m
HZ13	USB interface cable, 1,8 m
HZ14	Serial interface cable, Sub-D 9-pin, 1:1, 1,8 m

DIGITÁLNÍ MULTIMETR M 3860M METEX

3 3/4 digit, RS232C



ČTYŘI DIGITÁLNÍ STUPNICE MĚŘENÍ VÝKONU (4000W)

3 3/4 digit (max 4000)
V - A - Ω - F - Hz - W - kWh - cos φ - h_{fe} - °C
Automatické a ruční přepínání rozsahů
Analogový bargraf, Osvětlení stupnice
Automatické vypínání, vnitřní generátor

Funkce: A-H, D-H, R-H, MAX, MIN, REL, MEM, RCL, DUAL, EXT, CMP, UP-DOWN

Digitální multimetr METEX M 3860M představuje novou řadu multimetrů se čtyřmi digitálními displeji (main, sub1, sub2, sub3) a možností měření činného výkonu. M 3860M umožňuje měřit stejnosměrná a střídavá napětí a proudy, odpory, kapacity, kmitočty, činný výkon, účinník, h_{fe}. Lze jím testovat logické IO, apod. Multimetr M 3860M má vnitřní generátor kmitočtu obdélníkového průběhu. Speciální funkce multimetru (A-H, D-H, R-H, MIN, MAX, REL, CMP, MEM, RCL, UP-DOWN) jsou indikovány na třech displejích umístěných pod displejem hlavním a rozšiřují možnosti použití při měřeních. Standardně je multimetr vybaven pouzdem a měřicími hroty. Software s propojovacím kabelem MT/RS 232C pro připojení k PC (DOS, WINDOWS), kabel pro měření výkonu a kabel generátoru BNC-DIN jsou dodávány jako příslušenství.

TECHNICKÉ ÚDAJE:

DC napětí		
rozsah	rozlišení	přesnost ±(%rdg+dig)
400 mV	100 μV	0,3 % + 1
4 V	1 mV	0,3 % + 1
40 V	10 mV	0,3 % + 1
400 V	100 mV	0,3 % + 1
1000 V	1 V	0,5 % + 1
měření odporů		
rozsah	rozlišení	přesnost ±(%rdg+dig)
400 Ohm	0,1 Ohm	0,5 % + 1
4 kOhm	1 Ohm	0,5 % + 1
40 kOhm	10 Ohm	0,5 % + 1
400 kOhm	100 Ohm	0,5 % + 1
4 MOhm	1 kOhm	0,5 % + 1
40 MOhm	10 kOhm	1,0 % + 2
měření kondenzátorů		
rozsah	rozlišení	přesnost ±(%rdg+dig)
4 nF	1 pF	2,0% + 3
40 nF	10 pF	2,0% + 3
400 nF	100 pF	2,0% + 3
4 μF	1 nF	3,0% + 5
40 μF	10 nF	3,0% + 5
400 μF	100 nF	3,0% + 5
měření kmitočtu		
rozsah	rozlišení	přesnost ±(%rdg+dig)
4 kHz	1 Hz	0,1% + 1
40 kHz	10 Hz	0,1% + 1
400 kHz	100 Hz	0,1% + 1
4 MHz	1 kHz	0,1% + 1
40 MHz	10 kHz	0,1% + 1
Speciální funkce		
D-H, A-H, R-H, MAX, MIN, REL, CMP, EXT, MEM (10 pamětí), RCL		
Specifikace		
Displej	3 3/4 (4000) hlavní a tři duální	
Max. proud	20A	
Vzorkování	2,5 čtení / s	
Pracovní teplota	0 až 50°C / 75% RH	
Rozměry	84 x 187 x 34 mm	
Hmotnost	0,305kg	
Napájení	9 V baterie	

AC napětí		
rozsah	rozlišení	přesnost ±(%rdg+dig)
400 mV	100 μV	0,8 % + 3
4 V	1 mV	0,8 % + 3
40 V	10 mV	0,8 % + 3
400 V	100 mV	1,5 % + 3
750 V	1 V	1,5 % + 3
kmitočtové pásmo: 40Hz až 10kHz 500Hz < f < 10Hz: +/- (2,5 + 5)		
DC proudy		
rozsah	rozlišení	přesnost ±(%rdg+dig)
400 μA	0,1 μA	1,0 % + 1
4 mA	1 mA	1,0 % + 1
40 mA	10 μA	0,8 % + 1
400 mA	100 μA	0,8 % + 1
4 A	1 mA	1,5 % + 5
20 A	10 mA	1,5 % + 5
AC proudy		
rozsah	rozlišení	přesnost ±(%rdg+dig)
400 μA	0,1 μA	1,5 % + 3
4 mA	1 μA	1,5 % + 3
40 mA	10 μA	1,5 % + 3
400 mA	100 μA	1,5 % + 3
4 A	1 mA	2,0 % + 5
20 A	10 mA	2,0 % + 5
měření teploty (rozsah DMM)		
rozsah	rozlišení	přesnost ±(%rdg+dig)
-40°C - + 200°C	1°C	3,0% + 5
200°C - +1200°C	1°C	3,0% + 2
měření činného výkonu		
max. stř. proud	16A	
max. stř. napětí	180 až 250V	
činný výkon max.	4 000W (5% + 10)	
cos φ	00,00 až 00,99	
Vnitřní generátor		
obdélníkový průběh	(C-MOS obvody)	
kmitočty	10, 50, 60, 100, 400, 1010, 2021Hz	
výstupní úroveň	4.042, 8.082, 10,42kHz	
	3 VŠŠ	

Product Information

The M3510A 6 1/2 Digit Multimeter is the newest generation of DMM from Picotest. This new DMM offers compact size, light weight, fast measurement speed & throughput, expanded measurement functions, systematization capability and a highly usable interface including a standard USB interface and a GPIB/RS-232 interface. The M3510A DMM is suitable for both production and research/development use.

KEY FEATURES:

- 6 1/2 Digits High-Performance DMM
- High Speed: 50K RDGS/S
- Dual Measurements & Displays
- Temperature Measurements
- Multi-Measurement & Math Functions
- True RMS
- Easy-to-Use MENU
- Built-in USB Interface & USBTMC Conformance
- Quality Assurance
- Free Application Software

Detailed Specifications

6 1/2 Digits High-Performance DMM

The M3510A 6 1/2 Digits Multimeter is the newest generation of DMM from Picotest. This new DMM offers a compact size, light weight, fast measurement speed & throughput, expanded measurement functions, systematization capability and highly usable interfaces including a standard USB interface and a GPIB/RS-232 interface. The M3510A DMM is suitable for both production and research/development use.

50000 Readings/Sec Sampling Rate

M3510A adopts the latest A/D technology and achieve 50,000 readings per second at 4 1/2 digits. When sending data to your computer, M3510A can achieve high precision and stability compared to other DMMs with slow data transmission rate. With M3510A, your work efficiency will be greatly improved, and the operational cost will also be greatly reduced.

Dual Measurements & Displays

The dual measurement display feature of M3510A offers two measurement results displayed at the same time and it is easy to set up and configure. For example, when measuring DCV, you may also conduct Thermocouple measurement on M3510A. This allows you to observe temperature change while making other measurements. M3510A can function as a multimeter and a thermometer in one.

Temperature Measurements

The M3510A DMM supports the RTD temperature measurement and supports the standards such as ITS-90, IEC751 and Callendar-Van Dusen. The RTD function is recommended for more precise measurement. M3510A also provides the Thermocouple (TC) function. It has a built-in cold junction compensator for improved TC accuracy. Without additional plug-in's and reference temperature settings, you can measure temperature directly via Thermocouples of K, J, R, S, T, E, N, C and B types.

Multi-Measurement & Math Functions

The M3510A DMM offers the capacitance measurement and dual measurement display, in addition to standard measurements, such as DCV, DCI, ACV, ACI, $2W\Omega$, $4W\Omega$, Frequency, Period, Thermocouple & RTD, and the math functions, such as Limits, Ratio, MX+B, %, dBm, dB, Min/Max & Null. Measurement ranges have also been expanded. For instance, DC and AC Current Ranges now go up to 10 A.

True RMS

The M3510A DMM adopts an analog conversion technique to provide true RMS value for ACV/ACI measurements regardless of the waveform shape. Only the “heating value” of the AC components of the input waveform is measured. For non-symmetrical waveforms, such as pulse trains, the DC components will be rejected by the RMS measurement.

Simple to Use

Configuring the M3510A is straightforward. Unlike other DMMs with complicated operation modes in the configuration menu, M3510A offers easy-to-use SHIFT, CONFIG, ENTER buttons, arrow keys and corresponding soft keys at the lower part of the display across all the measurement configurations. Using equipments from Picotest just gets easier than ever.

Built-in USB Interface & USBTMC Conformance

A high-speed USB interface is built into the M3510A. A GPIB/RS-232 interface is also included. The included USB interface conforms to the USBTMC protocol. The M3510A and can be operated through USBTMC compliant software. So get the M3510A now to replace your old DMMs while keep your existing USBTMC compliant software.

Reliability

The M3510A DMM is of high reliability and complies with CE requirements, from well-packed cartons with the shock absorbing bumpers to careful component selection, circuit protection design, rigorous environmental tests and ISO9001 production. Defective products can be returned with free repair/calibration with one-year warranty.

A Sample Application (Current vs. Temperature)

The M3510A DMM is shipped with the PT-TOOL & PT-LINK software. With the software, you can quickly establish an error-free connection between your PC and the equipment. The M3510A conforms to Standard Commands for Programmable Instrumentation (SCPI). PT-TOOL is a virtual oscilloscope software, which can monitor the DUT with scope display style. PT-LINK is used to collect measurement data in Microsoft Excel or Word and analyze it with charts. In addition, engineers are allowed to compile our Labview Driver for specific applications.

Dimension Information

If problem occurs while operating M3510A, it is recommended to do the self-test first. If you need to perform basic adjustments for Zero & Gain, please follow the instructions in the M3510A Service Manual. A calibrator with at least 6 1/2-digit precision and a shorting plug are required. For a complete calibration with factory reports, contact your local service representative to return your DMM to PICOTEST.

Accessories

CD (user manual and software applications), power cord, test leads, and USB cable.
GPIB Interface Card
3 Year Warranty

The following options are available:

1. M3500-opt04: GPIB Card (now comes standard)
2. M3500-opt06: RS-232 Card
3. M3500-opt07: Kelvin Probe
4. M3500-opt08: 4-Wire Test Leads
5. M3500-opt10: Shorting Plug
6. M3500-opt11: K Type Thermocouple Probe

Specifications

DC Characteristics					
Function	Range	Resolution	1 Year Accuracy ²		
DC Voltage	100.0000 mV	0.1 μ V	0.0080+0.0045		
	1.000000 V	1.0 μ V	0.0090+0.0010		
	10.00000 V	10.0 μ V	0.0120+0.0020		
	100.0000 V	100.0 μ V	0.0120+0.0020		
DCI	1000.000 V	1 mV	0.0130+0.0030		
	10.00000 mA	10 nA	0.050+0.020		
	100.0000 mA	100 nA	0.050+0.010		
	1.000000 A	1 μ A	0.150+0.020		
2W Ω^3 /4W Ω	3.00000 A	10 μ A	0.20+0.030		
	10.00000 A	10 μ A	0.250+0.050		
	100.0000 Ω	100 $\mu\Omega$	0.020+0.005		
	1.000000 K Ω	1 m Ω	0.020+0.002		
	10.00000 K Ω	10 m Ω	0.020+0.002		
	100.0000 K Ω	100 m Ω	0.020+0.002		
	1.000000 M Ω	1 Ω	0.020+0.004		
DIODE	10.00000 M Ω	10 Ω	0.100+0.004		
	100.0000 M Ω	100 Ω	1.500+0.005		
CONTINUITY (for 2W Ω)	1.00000 V	10 μ V	0.020+0.020		
	1000.00 Ω	10 m Ω	0.020+0.030		
FREQUENCY & PERIOD					
Function	Range	Frequency (Hz)	1 Year Accuracy ²		
Frequency & Period	100 mV to 750 V ⁴	10-40	0.03		
		40-300K	0.02		
AC CHARACTERISTICS					
Function	Range	Resolution	Frequency (Hz)	1 Year Accuracy ²	
ACV (TRMS)	100.0000 mV	0.1 μ V	10-20K	0.1200 +0.050	
			20K-50K	0.2500+0.050	
	50K-100K		0.6500+0.080		
	100K-300K		4.5000+0.500		
	1.000000 V to 750.0000 V ⁴	1.0 μ V to 1 mV	10-20K	0.1200+0.040	
			20K-50K	0.2500+0.050	
50K-100K			0.6500 +0.080		
100K-300K			4.5000+0.500		
ACI (TRMS)	1.000000 A	1 μ A	10-1K	0.20+0.04	
	3.00000 A	10 μ A	1K-5K	1.00+0.10	
			10-1K	0.30 +0.06	
	10.00000 A	10 μ A	1K-5K	1.50+0.15	
			10-1K	0.50+0.10	
				1K-5K	2.0+0.20
CAPACITANCE CHARACTERISTICS					
Function	Range	Test Current	1 Year Accuracy ²		
CAPACITANCE ⁵	1 nF	10 μ A	2.0+0.80		
	10 nF	10 μ A	1.0+0.50		
	100 nF	100 μ A	1.0+0.50		
	1 μ F	100 μ A	1.0+0.50		
	10 μ F	100 μ A	1.0+0.50		
	100 μ F	1 mA	1.0+0.50		
	1000 μ F	1 mA	1.0+0.50		
	10000 μ F	1 mA	2.0+0.50		
	TEMPERATURE CHARACTERISTICS				
	Function	Type	Range	1 Year Accuracy ²	
THERMOCOUPLE ⁶	B	600°C-1820°C	1.5°C		
	C	0°C-2316°C	1.5°C		
	E	-250°C-1000°C	1.5°C		
	J	-210°C-1200°C	1.0°C		
	K	-200°C-1372°C	1.0°C		
	N	-200°C-1300°C	1.0°C		
	R	0°C-1767°C	1.5°C		
	S	0°C-1767°C	1.5°C		
	T	-250°C-400°C	1.5°C		

General Specifications

Item	Limitation & description
Power Supply	100V/120V/220V/240V ± 10%
Power Line Frequency	50/60 Hz ± 10%
Power Consumption	25 VA peak (5 W AVERAGE)
Operating Temperature	0 °C to 50 °C
Operating Humidity	Maximum relative humidity 80% for temperature up to 31 °C
Storage Temperature	- 40 °C to 70 °C
Operating Altitude	Up to 2000 M
Bench Dimensions (WxHxD)	214.6x88.6x280.7mm
Weight	2.23 KG
Safety ⁷	IEC61010-1:2001/EN61010-1:2001 (2nd Edition) Measurement CAT II 600V, CAT I 1000V Pollution Degree 2
EMC	EN61326-1:2006, EN61326-2-1:2006
VIBRATION	MIL-PRF-28800F, 3.8.4.2 VIBRATION, SINUSOIDAL CLASS 1,2
SHOCK	MIL-PFR-28800F, 4.5.5.4 MECHANICAL
Warranty	One Year

¹The specifications are under 2-hour warm-up condition with the setting 10 PLC, and they're relative to the calibrator specifications in PICOTEST.

² ± (% of reading + % of range), (23 °C ± 5 °C)

³The Null function must be used when the 2WΩ is adopted.

⁴ The Range 750 V is limited to 100 KHz.

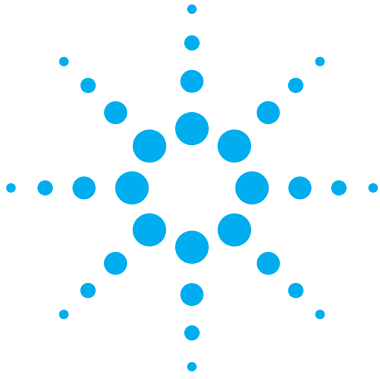
⁵ The Null function must be used.

⁶ The measured value must be plus the error of test leads.

⁷ The LO jack is marked with 500Vpk against ground and SENSE HI to LO is only marked with 200Vpk, in opposition to the label of 600V CAT II and/or 1000V CAT I against ground and IEC 61010-1.

Specifications are subject to change without notice.

All other trademarks and trade names are the property of their respective companies.



Agilent 34401A Multimeter

Data Sheet



- Measure up to 1000 volts with 6½ digits resolution
- 0.0015% basic dcV accuracy (24 hour)
- 0.06% basic acV accuracy (1 year)
- 3 Hz to 300 kHz ac bandwidth
- 1000 readings/s direct to GPIB

Superior Performance

The Agilent Technologies 34401A multimeter gives you the performance you need for fast, accurate bench and system testing. The 34401A provides a combination of resolution, accuracy and speed that rivals DMMs costing many times more. 6½ digits of resolution, 0.0015% basic 24-hr dcV accuracy and 1,000 readings/s direct to GPIB assure you of results that are accurate, fast, and repeatable.

Use It on Your Benchtop

The 34401A was designed with your bench needs in mind. Functions commonly associated with bench operation, like continuity and diode test, are built in. A Null feature allows you to remove lead resistance and other fixed offsets in your measurements. Other capabilities like min/max/avg readouts and direct dB and dBm measurements make checkout with the 34401A faster and easier.

The 34401A gives you the ability to store up to 512 readings in internal memory. For trouble-shooting, a reading hold feature lets you concentrate on placing your test leads without having to constantly glance at the display.

Use It for Systems Testing

For systems use, the 34401A gives you faster bus throughput than any other DMM in its class. The 34401A can send up to 1,000 readings/s directly across GPIB in user-friendly ASCII format.

You also get both GPIB and RS-232 interfaces as standard features. Voltmeter Complete and External Trigger signals are provided so you can synchronize to other instruments in your test system. In addition, a TTL output indicates Pass/Fail results when limit testing is used.

To ensure both forward and backward compatibility, the 34401A includes three command languages (SCPI, Agilent 3478A and Fluke8840A/42A), so you don't have to rewrite your existing test software. An optional rack mount kit is available.

See Agilent's Truevolt Series of DMMs

- Display DMM results in ways you never have before
- Measure with unquestioned Truevolt confidence
- Move to the next generation 34401A DMM with 100% assurance

www.agilent.com/find/dmm

Easy to Use

Commonly accessed attributes, such as functions, ranges, and resolution are selected with a single button press.

Advanced features are available using menu functions that let you optimize the 34401A for your applications.

The included Agilent IntuiLink software allows you to put your captured data to work easily, using PC applications such as Microsoft Excel or Word to analyze, interpret, display, print, and document the data you get from the 34401A. You can specify the meter setup and take a single reading or log data to the Excel spreadsheet in specified time intervals. Programmers can use ActiveX components to control the DMM using SCPI commands. To find out more about IntuiLink, visit www.agilent.com/find/intuilink

1-Year Warranty

With your 34401A, you get full documentation, a high-quality test lead set, calibration certificate with test data, and a 1-year warranty, all for one low price.



Agilent Technologies

Accuracy Specifications ± (% of reading + % of range)¹

Function	Range ³	Frequency, etc.	24 Hour ² 23°C ±1°C	90 Day 23°C ±5°C	1 Year 23°C ±5°C	Temperature Coefficient 0°C – 18°C 28°C – 55°C
DC voltage	100.0000 mV		0.0030 + 0.0030	0.0040 + 0.0035	0.0050 + 0.0035	0.0005 + 0.0005
	1.000000 V		0.0020 + 0.0006	0.0030 + 0.0007	0.0040 + 0.0007	0.0005 + 0.0001
	10.00000 V		0.0015 + 0.0004	0.0020 + 0.0005	0.0035 + 0.0005	0.0005 + 0.0001
	100.0000 V		0.0020 + 0.0006	0.0035 + 0.0006	0.0045 + 0.0006	0.0005 + 0.0001
	1000.000 V		0.0020 + 0.0006	0.0035 + 0.0010	0.0045 + 0.0010	0.0005 + 0.0001
True rms AC voltage ⁴	100.0000 mV	3 Hz – 5 Hz	1.00 + 0.03	1.00 + 0.04	1.00 + 0.04	0.100 + 0.004
		5 Hz – 10 Hz	0.35 + 0.03	0.35 + 0.04	0.35 + 0.04	0.035 + 0.004
		10 Hz – 20 kHz	0.04 + 0.03	0.05 + 0.04	0.06 + 0.04	0.005 + 0.004
		20 kHz – 50 kHz	0.10 + 0.05	0.11 + 0.05	0.12 + 0.05	0.011 + 0.005
		50 kHz – 100 kHz	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
	1.000000 V to 750.000 V	100 kHz – 300 kHz ⁶	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02
		3 Hz – 5 Hz	1.00 + 0.02	1.00 + 0.03	1.00 + 0.03	0.100 + 0.003
		5 Hz – 10 Hz	0.35 + 0.02	0.35 + 0.03	0.35 + 0.03	0.035 + 0.003
		10 Hz – 20 kHz	0.04 + 0.02	0.05 + 0.03	0.06 + 0.03	0.005 + 0.003
		20 kHz – 50 kHz	0.10 + 0.04	0.11 + 0.05	0.12 + 0.04	0.011 + 0.005
1.000000 MΩ to 750.000 MΩ	50 kHz – 100 kHz ⁵	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008	
	100 kHz – 300 kHz ⁶	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02	
	3 Hz – 5 Hz	1.00 + 0.02	1.00 + 0.03	1.00 + 0.03	0.100 + 0.003	
	5 Hz – 10 Hz	0.35 + 0.02	0.35 + 0.03	0.35 + 0.03	0.035 + 0.003	
	10 Hz – 20 kHz	0.04 + 0.02	0.05 + 0.03	0.06 + 0.03	0.005 + 0.003	
Resistance ⁷	100.0000 Ω	1 mA Current Source	0.0030 + 0.0030	0.008 + 0.004	0.010 + 0.004	0.0006 + 0.0005
	1.000000 kΩ	1 mA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	10.00000 kΩ	100 μA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	100.0000 kΩ	10 μA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	1.000000 MΩ	5.0 μA	0.002 + 0.001	0.008 + 0.001	0.010 + 0.001	0.0010 + 0.0002
	10.00000 MΩ	500 nA	0.015 + 0.001	0.020 + 0.001	0.040 + 0.001	0.0030 + 0.0004
	100.0000 MΩ	500 nA 10 MΩ	0.300 + 0.010	0.800 + 0.010	0.800 + 0.010	0.1500 + 0.0002
DC current	10.00000 mA	< 0.1 V Burden Voltage	0.005 + 0.010	0.030 + 0.020	0.050 + 0.020	0.0020 + 0.0020
	100.0000 mA	< 0.6 V	0.010 + 0.004	0.030 + 0.005	0.050 + 0.005	0.0020 + 0.0005
	1.000000 A	< 1.0 V	0.050 + 0.006	0.080 + 0.010	0.100 + 0.010	0.0050 + 0.0010
	3.00000 A	< 2.0 V	0.100 + 0.020	0.120 + 0.020	0.120 + 0.020	0.005 + 0.0020
True rms AC current ⁴	1.000000 A	3 Hz – 5 Hz	1.00 + 0.04	1.00 + 0.04	1.00 + 0.04	0.100 + 0.006
		5 Hz – 10 Hz	0.30 + 0.04	0.30 + 0.04	0.30 + 0.04	0.035 + 0.006
		10 Hz – 5 kHz	0.10 + 0.04	0.10 + 0.04	0.10 + 0.04	0.015 + 0.006
	3.00000 A	3 Hz – 5 Hz	1.10 + 0.06	1.10 + 0.06	1.10 + 0.06	0.100 + 0.006
		5 Hz – 10 Hz	0.35 + 0.06	0.35 + 0.06	0.35 + 0.06	0.035 + 0.006
		10 Hz – 5 kHz	0.15 + 0.06	0.15 + 0.06	0.15 + 0.06	0.015 + 0.006
Frequency or period ⁸	100 mV to 750 V	3 Hz – 5 Hz	0.10	0.10	0.10	0.005
		5 Hz – 10 Hz	0.05	0.05	0.05	0.005
		10 Hz – 40 Hz	0.03	0.03	0.03	0.001
		40 Hz – 300 kHz	0.006	0.01	0.01	0.001
Continuity	1000.0 Ω	1 mA test current	0.002 + 0.030	0.008 + 0.030	0.010 + 0.030	0.001 + 0.002
Diode test ⁹	1.0000 V	1 mA test current	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.001 + 0.002

1. Specifications are for 1 hr warm-up and 6½ digits, slow ac filter.

2. Relative to calibration standards.

3. 20% over range on all ranges except 1000 Vdc and 750 Vac ranges.

4. For sinewave input > 5% of range. For inputs from 1% to 5% of range and < 50 kHz, add 0.1% of range additional error.

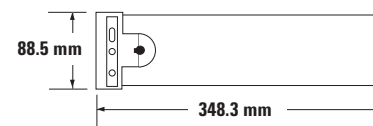
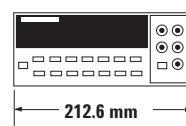
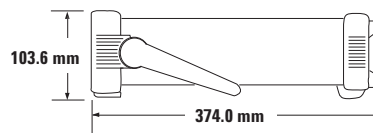
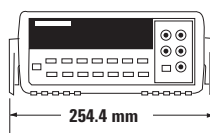
5. 750 V range limited to 100 kHz or 8×10^7 Volt-Hz.

6. Typically 30% of reading error at 1 MHz.

7. Specifications are for 4-wire ohms function or 2-wire ohms using Math Null. Without Math Null, add 0.2 Ω additional error in 2-wire ohms function.

8. Input > 100 mV. For 10 mV to 100 mV inputs multiply % of reading error x10.

9. Accuracy specifications are for the voltage measured at the input terminals only. 1 mA test current is typical. Variation in the current source will create some variation in the voltage drop across a diode junction.



Measurement Characteristics

DC Voltage

Measurement Method:
Continuously integrating multi-slope III A-D converter

A-D Linearity: 0.0002% of reading + 0.0001% of range

Input Resistance:
10 M Ω or 0.1 V, 1 V, 10 V ranges:
Selectable > 10,000 M Ω
100 V, 1000 V ranges: 10 M Ω \pm 1%
Input Bias Current: < 30 pA at 25°C

Input Protection: 1000 V all ranges

dcV:dcV ratio accuracy:
 $V_{input} Accuracy + V_{relevance} Accuracy$

True RMS AC Voltage

Measurement Method:
AC-coupled true rms-measures the ac component of the input with up to 400 Vdc of bias on any range.

Crest Factor:
Maximum of 5:1 at full scale.

Additional Crest Factor errors (non-sinewave):
Crest factor 1-2: 0.05% of reading
Crest factor 2-3: 0.15% of reading
Crest factor 3-4: 0.30% of reading
Crest factor 4-5: 0.40% of reading

Input Impedance:
1 M Ω \pm 2% in parallel with 100 pF
Input Protection: 750 Vrms all ranges

Resistance

Measurement Method:
Selectable 4-wire or 2-wire Ohms.
Current source referenced to LO input.

Maximum Lead Resistance (4-wire):
10% of range per lead for 100 Ω , 1 k Ω ranges.
1 k Ω per lead on all other ranges.

Input Protection: 1000 V all ranges

DC Current

Shunt Resistance:
5 Ω for 10 mA, 100 mA
0.1 Ω for 1 A, 3 A

Input Protection:
Externally accessible 3 A 250 V fuse
Internal 7 A 250 V fuse

True RMS AC Current

Measurement Method:
Directly coupled to the fuse and shunt.
ac coupled true rms measurement (measures the ac component only).

Shunt Resistance:
0.1 Ω for 1 A and 3 A ranges

Input Protection:
Externally accessible 3 A 250 V fuse
Internal 7 A 250 V fuse

Frequency and Period

Measurement Method:
Reciprocal counting technique

Voltage Ranges:
Same as ac voltage function

Gate Time: 1 s, 100 ms, or 10 ms

Continuity/Diode

Response Time:
300 samples/s with audible tone

Continuity Threshold:
Selectable from 1 Ω to 1000 Ω

Measurement Noise Rejection 60 (50) Hz¹

dc CMRR: 140 dB
ac CMRR: 70 dB

Integration Time and Normal Mode Rejection²

100 plc/1.67 s (2 s): 60 dB³
10 plc/167 ms (200 ms): 60 dB³
1 plc/16.7 ms (20 ms): 60 dB
<1 plc/3 ms or 800 μ s): 0 dB

Operating Characteristics⁴

Function	Digits	Reading/s
dcV, dcl, and Resistance	6 $\frac{1}{2}$	0.6 (0.5)
	6 $\frac{1}{2}$	6 (5)
	5 $\frac{1}{2}$	60 (50)
	5 $\frac{1}{2}$	300
	4 $\frac{1}{2}$	1000
acV, acl	6 $\frac{1}{2}$	0.15 slow (3 Hz)
	6 $\frac{1}{2}$	1 medium (20 Hz)
	6 $\frac{1}{2}$	10 fast (200 Hz) ⁵
	6 $\frac{1}{2}$	50
Frequency or Period	6 $\frac{1}{2}$	1
	5 $\frac{1}{2}$	9.8
	4 $\frac{1}{2}$	80

System Speeds

Configuration rates: 26/s to 50/s
Autorange rate (dc Volts): >30/s
ASCII readings to RS-232: 55/s
ASCII readings to RS-232: 1000/s
Maximum internal trig rate: 1000/s
Max. ext trig. rate to mem: 1000/s

Triggering and Memory

Reading HOLD Sensitivity:
10%, 1%, 0.1%, or 0.01% of range

Samples/Trigger: 1 to 50,000

Trigger Delay: 0 to 3600 s: 10 μ s step size

External Trigger Delay: < 1 ms

External Trigger Jitter: < 500 μ s

Memory: 512 readings

Math Functions

NULL, min/max/average, dBm, dB, limit test (with TTL output)

Standard Programming Languages

SCPI (IEEE-488.2), Agilent 3478A, Fluke 8840A/42A

Accessories Included

Test lead kit with probe, alligator and grabber attachments
Operating manual, service manual, test report and power cord

General Specifications

Power Supply:
100 V/120 V/220 V/240 V \pm 10%

Power Line Frequency:
45 Hz to 66 Hz and 360 Hz to 440 Hz,
Automatically sensed at power-on

Power Consumption: 25 VA peak (10 W average)

Operating Environment:
Full accuracy for 0°C to 55°C,
Full accuracy to 80% R.H. at 40°C

Storage Temperature: -40°C to 70°C

Weight: 3.6 kg (8.0 lbs)

Safety: Designed to CSA, UL-1244, IEC-348

RFI and ESD: MIL-461C, FTZ 1046, FCC

Vibration & Shock: MIL-T-28800E, Type III, Class 5 (sine only)

Warranty: 1 year

1. For 1 k Ω unbalanced in LO lead, \pm 500 V peak maximum.
2. For power line frequency \pm 0.1%.
3. For power line frequency \pm 1% use 40 dB or \pm 3% use 30 dB.
4. Reading speeds for 60 Hz and (50 Hz) operation.
5. Maximum useful limit with default settling delays defeated.
6. Speeds are for 4 $\frac{1}{2}$ digits, delay 0, auto-zero and display OFF.

Ordering Information

Agilent 34401A multimeter accessories included: Test lead kit with probe, alligator, and grabber attachments, calibration certificate, test report, and power cord. Also includes CD with: IntuiLink software, IVI and VXI PnP drivers, Quick start tutorial, user's guide, command quick reference, service guide, and data sheet.

Options

34401A-A6J

ANSI Z540 compliant calibration

Accessories

Probes/Leads/Clip Accessories

11059A Kelvin probe set

11060A Surface mount device (SMD) test probes

11062A Kelvin clip set

34133A Precision electronic test leads

34134A DC coupled current probe

34136A High voltage probe

34138A Test lead set

34171B Input terminal connector
(sold in pairs)

34172B Input calibration short
(sold in pairs)

34330A 30 A current shunt

E2308A 5 k thermistor probe

Y1133A Low-thermal external digital multimeter scanning kit

Rack Mount Kits

34190A Rackmount kit: designed for use with only one instrument, mounted on either the left or the right side of the rack.

34191A 2U Dual flange kit: secures the instrument to the front of the rack. This kit can be used with the 34194A dual lock link kit to mount two half-width, 2U height instruments side-by-side.

34194A Dual lock link kit: recommended for side-by-side combinations and includes links for instruments of different depths. This kit can be used with the 34191A 2U dual flange kit to mount two half-width, 2U height instruments side-by-side.

Other Accessories

34131A Hard transit case

34161A Accessory pouch

34398A RS-232 cable, 9 pin (f) to 9 pin (f)

E5810A LAN/GPIB gateway



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