AK-285R
Shielding Effectiveness
Antenna Kit
Operation Manual

REV D

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WARRANTY INFORMATION

A.H. Systems Inc., warrants that our Antennas, Sensors and Probes will be free from defects in materials and workmanship for a period of three (3) years. All other products delivered under contract will be warranted for a period of two (2) years. Damage caused by excessive signals at the product's input is not covered under the warranty. A.H. Systems' obligation under this warranty shall be limited to repairing or replacing, F.O.B. Chatsworth, California, each part of the product which is defective, provided that the buyer gives A.H. Systems notice of such defect within the warranty period commencing with the delivery of the product by A.H. Systems.

The remedy set forth herein shall be the only remedy available to the buyer, and in no event shall A.H. Systems be liable for direct, indirect, incidental or consequential damages.

This warranty shall not apply to any part of the product which, without fault of A.H. Systems has been subject to alteration, failure caused by a part not supplied by A.H. Systems, accident, fire or other casualty, negligence, misuse or normal wear of materials.

Except for the warranty set forth above, there are no other warranties, expressed or implied, with respect to the condition of the product or it's suitability for the use intended for them by the buyer.

For prompt service, please contact our service department for a Return Material Authorization Number before shipping equipment back to us.

INTRODUCTION

Shown with optional preamplifiers

ANTENNA KIT CONTENTS

Model Number	Frequency Range	Description
SAS-510-2	290 MHz – 2000 MHz	Log Periodic
SAS-544F	20 MHz – 330 MHz	Biconical, Folding
SAS-550-1B	9 KHz – 60 MHz	Active Monopole
SAS-563B	1 KHz – 30 MHz	Active Loop
SAS-571	700 MHz – 18 GHz	Double ridge guide horn
SAC-18G-3	Up to 18 GHz	3 Meter Low-Loss Cable
TSC-285R		Transit Storage Case
ADP-201		N(m) to BNC(f) Adapter
ADP-202		N(f) to BNC(m) Adapter
ATU-510		Wood Tripod
AEH-510		Azimuth and Elevation Head
TCC-510		Tripod Carrying Case
OPTIONAL EQUIPMENT		
PAM-0118P	20 MHz – 18 GHz	37 dB Preamplifier
SAC-18G-0.5	Up to 18 GHz	0.5 Meter Low-Loss Cable
	Tripod Case	**Antenna Case**
Dimensions:	46” x 8” Dia.	28” x 23” x 10”
Weight:	18.6 lbs.	38 lbs.

GENERAL INFORMATION

INTENDED PURPOSES

This equipment is intended for general laboratory use in a wide variety of industrial and scientific applications, and designed to be used in the process of measuring high levels of electromagnetic Radio Frequency (RF) energy. It is the responsibility of the user to assure that the device is operated in a location which will measure the radiated energy such that it will not cause injury and will not violate regulatory levels of electromagnetic interference.

GENERAL DESCRIPTION

The A.H. Systems AK-285R and AK-285T antenna kits includes all of the required antennas needed to perform shielding effectiveness. Each component has a specific storage compartment in the carrying case therefore, loss and breakage are virtually eliminated. Cables, a tripod with azimuth and elevation head, and a tripod carrying case accompany each antenna kit. Each of the antennas, and cables, are provided with calibrations when connected to a 50-ohm input receiver or spectrum analyzer.

Each of the E-field antennas mounts directly to the tripod azimuth and elevation head. The azimuth and elevation head allows the operator to vary the antenna azimuth (direction) and tilt the antenna up and down. The antenna polarity can also be rotated (horizontal or vertical).

Cables and an adapter are provided to connect each antenna and probe to either a BNC or N type connector on the receiver.

To obtain the field strength of the signal being measured, the operator must add the receiver reading in dBuV, the antenna factor in dB/m, and the cable attenuation in dB. This yields the field strength in dBuV/m. Calibrations for the E-field antennas are supplied at appropriate distances (1, 3, and 10 meter) to comply with various specification requirements.

SAS-510-2

Log Periodic Antenna

290 MHz – 2 GHz

This directional Log Periodic Antenna is an ideal solution for radiated emissions and normalized site attenuation.

Frequency Range:	290 MHz - 2000 MHz
Antenna Factor:	14 - 32 dB/m
Gain:	6.5 dBi
Maximum Continuous Power:	1000 Watts
Maximum Radiated Field:	200 V/m
Pattern Type:	directional
3dB Beamwidth (E-Field):	45°
3dB Beamwidth (H-Field):	100°
Impedance:	50 Ω
VSWR:	1.45:1 typ. (2.2:1 max)
Connector:	N-Type, Female
Mounting Base:	¼ x 20 Thread, Female

Features

- Frequency Range of 290 MHz to 2000 MHz
- Receive and Transmit
- Individually Calibrated (1, 3 and 10 Meter Horizontal calibration included)
- Rugged Construction
- Three Year Warranty

The SAS-510-2 Log Periodic Antenna (also known as a log periodic dipole array) is a compact, lightweight antenna that has been designed to ensure maximum gain, low VSWR and high-power handling capabilities. This compact design is an ideal solution for EMC testing where the reduced size of the antenna is preferred to minimize chamber wall coupling and increasing the half power beamwidth to a more acceptable angle that will cover the whole device under test. Constructed of lightweight aluminum, the SAS-510-2 Log Periodic Antenna has been manufactured to operate over a very wide bandwidth. Weighing in at just 1.5 pounds this Log Periodic Antenna is one of the lightest antennas commercially available.

Assembly: The log periodic antenna comes assembled and ready to use.

Operation: Attach the antenna to the tripod azimuth and elevation head through the screw hole in the antenna base. Connect a cable between the antenna connector and the receiver. The log periodic beamwidth is 65 degrees and it should be pointed or aimed in the direction that the horizontal received signal is coming from.

SAS-544F

High Field Biconical Antenna, Folding

20 MHz – 300 MHz

This Biconical antenna has a coaxial wound balun that can handle High fields of RF energy.

Frequency Range:	20 MHz - 300 MHz
Antenna Factor:	6 to 21 dB/m
Gain:	-23 to 2.8 dBi
Maximum Continuous Power:	300 Watts
Max Radiated Field:	20 V/m
Pattern Type:	omni-directional
Impedance:	50 Ω
Connector:	N-Type, female
Mounting Base:	¼ - 20 Thread, female

Features

- Frequency Range of 20 MHz to 300 MHz
- Receive and Transmit
- Individually Calibrated (1, 3 and 10 Meter calibration included, horizontal polarization)
- Rugged Construction
- Three Year Warranty

The SAS-544F Folding Biconical Antenna was the first EMC antenna designed for portable compliance testing applications. This Biconical Antenna is designed with a coaxial wound balun for increased power capability and intended for both transmitting and receiving high electromagnetic RF fields. For rapid deployment, along with the mobility of a small package, the Folding Biconical elements can be closed similar to an umbrella allowing the antenna to be contained in an optional transit storage case. Whether testing in a shielded enclosure, or outdoors, the rugged construction of the A.H. Systems Biconical antenna will ensure long life, and reliable performance.

Assembly: The biconical antenna consists of the SAS-544F balun assembly, balun clamp assembly and two folding biconical elements.

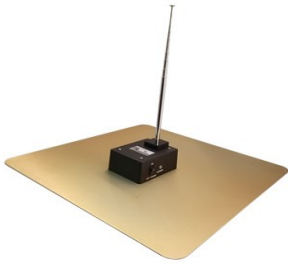
Operation: Attach the balun assembly to the tripod azimuth and elevation head with the balun clamp. Screw the two biconical elements into the 'tee' end of the balun assembly. Open the antenna elements completely and secure in open position by tightening the knurled knobs in the element caps. Connect a cable between the antenna connector and the receiver. The biconical beam pattern is similar to a dipole response.

SAS-550-1B

Active Monopole Antenna

9 KHz – 60 MHz

A.H. Systems Active Monopole Antenna is an active, general-purpose, receive-only monopole antenna.



Frequency Range:	9 kHz - 60 MHz
Antenna Factor:	0 dB
Impedance:	50 Ω (output port)
Pattern Type:	omni-directional
Output Connector:	BNC-Type, female
Batteries:	$12V_{DC}$ NiMH 2000mAh
Average Battery Life:	16 hours (fully charged new battery)
Mounting Base:	¼-20 Thread, female

Features

- Frequency Range of 9 KHz to 60 MHz
- Individually Calibrated (ANSI C63.5, IEEE-291 ECSM)
- Battery Powered, High Sensitivity
- Three Year Warranty

This active, general-purpose, receive-only monopole antenna covers the frequency range of 9 KHz to 60 MHz. It is ideal for instantaneous bandwidth scanning (without tuning) of electric fields in its frequency range and can drive any receiver with 50-ohm input impedance. This antenna is an ideal solution to perform FCC, MIL-STD, shielding effectiveness and TEMPEST type tests. The SAS-550-1B comes with a telescoping rod, ground plane, high impedance matched preamplifier and battery charger. This active monopole 104cm rod antenna has a signal output connector that is electrically bonded to the matching network case per MIL-STD 461F.

Assembly: The amplifier and ground plane can be mounted to any tripod with a 1/4-20 attaching stud. Attach the rod antenna to the connector on the top of the amplifier. Extend the rod antenna to 41" (104 cm) above the ground plane. Connect the output BNC connector on the side of the amplifier to the input of a 50-ohm receiver or spectrum analyzer. Establish a ground connection to the ground plane if required by the test specification. Do not operate the Monopole antenna with the Battery Charger connected.

Operation: Mount the antenna on the tripod. Connect an external ground to the ground plane if called out in test specification. Attach the telescoping rod to the top of the amplifier. Connect the output on amplifier side to the receiver using a cable. Turn the power switch on to operate the antenna.

SAS-563B

Active Shielded Loop Antenna

1 KHz – 30 MHz

This 12" Broadband loop antenna with preamplifier is an excellent solution for magnetic field testing.

Frequency Range: 1 kHz - 30 MHz
Impedance: 50 Ω
Connector: BNC, Female
Mounting Base: ¼ x 20 Thread, Female

Features

- Broad Frequency Range of 1 KHz to 30 MHz
- Individually Calibrated (Calibration included per IEEE-291)
- Battery Powered, High sensitivity
- Three Year Warranty

A.H. Systems' designs, manufactures and delivers high performance Loop Antennas for a wide range of magnetic field testing. Whether used in a set to measure shielding effectiveness per MIL-STD 285 and NSA 65-6, or individually to satisfy specific requirements, the Loop Antenna is an efficient, low-cost solution.

Assembly: The antenna can be mounted to any tripod with a 1/4-20 attaching stud. Connect the output BNC connector on the side of the antenna to the input of a 50-ohm analyzer or receiver. Do not operate the loop antenna with the Battery Charger connected.

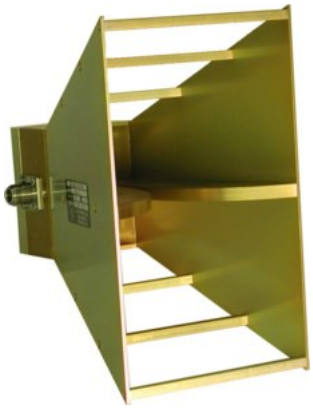
Operation: Mount the antenna on the tripod. Connect the output on amplifier side to the receiver using a cable. Turn the power switch on to operate the antenna.

SAS-571

Double Ridge Guide Horn Antenna

700 MHz – 18 GHz

High gain, low VSWR, input handling capability up to 300 watts CW, and rugged design make this horn antenna excellent for both immunity and emissions testing.



Frequency Range:	700 MHz - 18 GHz
Antenna Factor:	22 to 44 dB/m
Gain (dBi):	1.4 to 15 dBi
Maximum Continuous Power:	300 Watts
Max Radiated Field:	200 V/m
Pattern Type:	directional
3dB Beamwidth (E-Field):	48°
3dB Beamwidth (H-Field):	30°
Impedance:	50 Ω
VSWR:	1.6:1 (3.5:1 max)
Connector:	N-Type, female
Mounting Base:	¼ - 20 Thread, female

Features

- Broad Frequency Range of 700 MHz to 18 GHz
- Linearly Polarized High Gain, Low VSWR
- Individually Calibrated
- Three-year Warranty

The SAS-571 Double Ridge Guide Horn Antenna is lightweight, compact and has been manufactured for maximum gain, low VSWR and broadband response. The double ridge guide horn antenna was initially designed for surveillance where a high gain broadband response was required. The original design was to have a 30-degree beamwidth, which is ideal for EMI measurements and compliance testing.

Assembly: The horn antenna comes assembled and ready to use. The antenna mounting bracket is attached to the antenna backwards in order to fit in the carrying case. The bracket must be removed from the antenna, rotated (so that the bracket leg faces away from the antenna), and re-attached to the antenna. (The bracket is not needed for mounting if the tripod being used has an Azimuth/Elevation Head.)

Operation: Attach the antenna to the tripod azimuth and elevation head through the threaded hole on the antenna bottom or the threaded hole in the mounting bracket. The ridge guides determine the antenna polarity: for horizontal polarity they should be parallel to the ground and for vertical polarity they should be perpendicular to the ground. Connect a cable between the antenna connector and the receiver. NOTE: BE SURE TO USE A CABLE RATED FOR HIGH FREQUENCY WHEN OPERATING ABOVE 5 GHz (for example, the SAC-18G-3).

TRIPOD AND MOUNTING ADPTERS

ATU-510 Tripod

AEH-510 Azimuth and Elevation Head

The azimuth and elevation head (AEH-510) mounts to the tripod (ATU-510) top and allows the antennas to be rotated 360 degrees, titled up and down between horizontal and vertical polarization. The tripod and azimuth and elevation head come in their own carrying case. Each tripod leg is independently adjustable in angle and length to facilitate antenna height setting. The tripod legs have a rubber tip on one end for indoor or hard surface use, and a metal spike on the other end for outdoor soft surface (such as dirt) use.

TRANSIT STORAGE CASES

TCC-510 Tripod Carrying Case

TSC-542 Transit Storage Case

The antenna carrying case (TSC-542) prevents damage and loss of antennas when storing or transporting the antenna kit. The case is constructed of lightweight and durable polyethylene. Two case keys are provided with the case.

OPTIONAL EQUIPMENT

The AK-285R case comes with three additional cutouts for optional preamplifiers. In order to improve overall system sensitivity, the following equipment will be required:

- PAM-0118P with an SAC-18G-0.5
- PAM-1840 with an SAC-40G-0.5

PAM-0118P Preamplifier 20 MHz – 18 GHz

The preamplifier will increase the system sensitivity 37 dB and is recommend for the SAS-510-2, SAS-544F and SAS-571. An optional short length cable (SAC-18G-0.5), is required to connect the preamplifier to any 50-ohm receiver or spectrum analyzer. NOTE: Care must be exercised to ensure that the maximum input signal or ESD does not exceed +10 dBm causing damaged to the preamplifier.

SAC-18G-0.5 Low-Loss Cable up to 18 GHz

The Low-Loss, High Frequency cable is recommended for connecting the optional preamplifier to any 50-ohm receiver or spectrum analyzer. Our Low-Loss High-Frequency flexible cables are the preferred choice over standard cable types. With improved power handling, low VSWR, and high frequency capabilities, the Low-Loss cables can be made to your specified length and delivered in two days. The 1/2 meter SAC-18G-0.5 has a typical attenuation of 1.0 dB at 18GHz.

AK-285R and AK-285T
Dynamic Range Calculations

Here is a sample calculation of the required dynamic range at a 1 meter separation. Both the monopole and loop antennas have one passive and one active antenna. The use of preamplifiers with the active antennas is not recommended.

	Noise Level (10 Hz RB)	Vt-Vr	S + N / N	Xmtr Amp Margin	0 dB Sig Gen Dynamic Range	Preamp Gain	Dynamic Range with Preamp	1 Watt Power Amp	Dynamic Range with 1W Power Amp
Monopoles									
1 MHz	-130	18	6	6	100			30	130
5 MHz	-130	19	6	6	99			30	129
10 MHz	-130	17.5	6	6	100.5			30	130.5
20 MHz	-134	9	6	6	113			30	143
40 MHz	-134	8	6	6	114			30	144
50 MHz	-134	3	6	6	119			30	149
Loops									
1 MHz	-130	52	6	6	66			30	96
5 MHz	-130	39	6	6	79			30	109
10 MHz	-130	31	6	6	87			30	117
20 MHz	-134	38	6	6	84			30	114
40 MHz	-134	51.5	6	6	70.5			30	100.5
50 MHz	-134	53.5	6	6	68.5			30	98.5
Biconicals									
20 MHz	-134	33.5	6	6	88.5	40	128.5		
50 MHz	-134	23.6	6	6	98.4	40	138.4		
100 MHz	-134	12.8	6	6	109.2	40	149.2		
200 MHz	-134	17.9	6	6	104.1	40	144.1		
300 MHz	-134	26.6	6	6	95.4	40	135.4		
Log Periodics									
300 MHz	-134	13.4	6	6	108.6	40	148.6		
500 MHz	-134	13.8	6	6	108.2	40	148.2		
1 GHz	-134	19.4	6	6	102.6	40	142.6		
1.5 GHz	-134	24.1	6	6	97.9	40	137.9		
2 GHz	-134	26.3	6	6	95.7	40	135.7		

	Noise Level (10 Hz RB)	Vt-Vr	$\frac{S+N}{N}$	Xmtr Amp Margin	0 dB Sig Gen Dynamic Range	Preamp Gain	Dynamic Range with Preamp	1 Watt Power Amp	Dynamic Range with 1W Power Amp
DRG Horns									
1 GHz	-134	18.8	6	6	103.2	37	140.2		
2 GHz	-134	24.1	6	6	97.9	38	135.9		
5 GHz	-138	28.6	6	6	97.4	39.5	136.9		
10 GHz	-135	29.2	6	6	93.8	37	130.8		
15 GHz	-130	31.6	6	6	86.4	39	125.4		
18 GHz	-130	38.2	6	6	79.8	38	117.8		

Noise Level: This is the noise level of an HP 8563E Spectrum analyzer at 10 Hz resolution bandwidth

Vt – Vr: This is the path loss at 1 meter between the transmitting and receiving antennas.

$\frac{S+N}{N}$: This is the signal to noise floor safety margin.

Xmtr Amp Margin: Transmitting amplifier safety margin

0 dB Sig Gen Dynamic Range: This is the resulting system dynamic range of the two antennas with 0 dB out from the signal generator.

Preamp Gain: this is the typical gain of the PAM-0118P preamplifier that will cover 20 MHz – 18 GHz.

Dynamic range with preamplifiers: This is the resulting dynamic range where preamplifiers are used.

1 Watt Power amplifier: This is the gain in dynamic range using a 1 watt amplifier.

Dynamic Range with 1 watt amplifier: This is the resulting dynamic range when using a power amplifier.

ANTENNA FORMULAS AND CALCULATIONS

E-FIELD ANTENNAS

Add antenna factor plus cable loss to receiver reading in dBuV to convert to field strength in dBuV/meter.

Field Strength(dBuV/m) = SA(dBuV) + AF(dB/m) + cable loss (dB)

LOOP ANTENNA

Add the magnetic antenna factor plus cable loss to receiver reading in dBuV to convert to field strength in dBuA/meter.

dBuA/m = dBuV + Magnetic AF(dB/m) + Cable Loss
dBuV/m = dBuA/m + 51.5 dB

TYPICAL CONVERSION FORMULAS

LOG -> LINEAR VOLTAGE

dBμV to Volts	$V = 10^{((dB\mu V - 120) / 20)}$
Volts to dBμV	$dB\mu V = 20 \log(V) + 120$
dBV to Volts	$V = 10^{(dBV / 20)}$
Volts to dBV	$dBV = 20\log(V)$
dBV to dBμV	$dB\mu V = dBV + 120$
dBμV to dBV	$dBV = dB\mu V - 120$

LOG -> LINEAR CURRENT

dBμA to uA	$\mu A = 10^{(dB\mu A / 20)}$
μA to dBμA	$dB\mu A = 20 \log(\mu A)$
dBA to A	$A = 10^{(dBA / 20)}$
A to dBA	$dBA = 20\log(A)$
dBA to dBμA	$dB\mu A = dBA + 120$
dBμA to dBA	$dBA = dB\mu A - 120$

LOG -> LINEAR POWER

dBm to Watts	$W = 10^{((dBm - 30)/10)}$
Watts to dBm	$dBm = 10\log(W) + 30$
dBW to Watts	$W = 10^{(dBW / 10)}$
Watts to dBW	$dBW = 10\log(W)$
dBW to dBm	$dBm = dBW + 30$
dBm to dBW	$dBW = dBm - 30$

TERM CONVERSIONS

dBm to dBμV	$dB\mu V = dBm + 107$ (50Ω) *$dB\mu V = dBm + 10\log(Z) + 90$*
dBμV to dBm	$dBm = dB\mu V - 107$ (50Ω) *$dBm = dB\mu V - 10\log(Z) - 90$*
dBm to dBμA	$dB\mu A = dBm - 73$ (50Ω) *$dB\mu A = dBm - 10\log(Z) + 90$*
dBμA to dBm	$dBm = dB\mu A + 73$ (50Ω) *$dBm = dB\mu A + 10\log(Z) - 90$*
dBμA to dBμV	$dB\mu V = dB\mu A + 34$ (50Ω) *$dB\mu V = dB\mu A + 20\log(Z)$*
dBμV to dBμA	$dB\mu A = dB\mu V - 34$ (50Ω) *$dB\mu A = dB\mu V - 20\log(Z)$*

FIELD STRENGTH & POWER DENSITY

dBμV/m to V/m	$V/m = 10^{(((dB\mu V/m) - 120) / 20)}$
V/m to dBμV/m	$dB\mu V/m = 20 \log(V/m) + 120$
dBμV/m to dBmW/m²	$dBmW/m^2 = dB\mu V/m - 115.8$
dBmW/m² to dBμV/m	$dB\mu V/m = dBmW/m^2 + 115.8$
dBμV/m to dBμA/m	$dB\mu A/m = dB\mu V/m - 51.5$
dBμA/m to dBμV/m	$dB\mu V/m = dB\mu A + 51.5$
dBμA/m to dBpT	$DBpT = dB\mu A/m + 2$
dBpT to dBμA/m	$dB\mu A/m = dBpT - 2$
W/m² to V/m	$V/m = SQRT(W/m^2 * 377)$
V/m to W/m²	$W/m^2 = (V/m)^2 / 377$
μT to A/m	$A/m = \mu T / 1.25$
A/m to μT	$\mu T = 1.25 * A/m$

E-FIELD ANTENNAS

Correction Factor	$dB\mu V/m = dB\mu V + AF$
Field Strength	$V/m = \sqrt{\frac{30 * watts * Gain_{numeric}}{meters}}$
Required Power	$Watts = \frac{(V/m * meters)^2}{30 * Gain_{numeric}}$

LOOP ANTENNAS

Correction Factors	$dB\mu A/m = dB\mu V + AF$
Assumed E-field for shielded loops	$dB\mu V/m = dB\mu A/m + 51.5$
	$dBpT = dB\mu V + dBpT/\mu V$

CURRENT PROBES

Correction Factor	$dB\mu A = dB\mu V - dB_{(ohm)}$

Power needed for injection probe given voltage(V) into 50Ω load and Probe Insertion Loss (I_L)

$$Watts = 10^{((I_L + 10\log(V^2/50))/10)}$$

MAINTENANCE

MAINTENANCE PROCEDURES

Proper antenna maintenance should include:

- Visual inspection of RF connectors
- Check for loose or missing hardware
- Check for corrosion near the joints

At least once a month it is a good idea to wipe down the antenna with a damp rag.

ANNUAL CALIBRATION

To ensure reliable and repeatable long-term performance, annual re-calibration of your antennas, preamplifiers and current probes by A.H. Systems experienced technicians is recommended. Our staff can calibrate almost any type or brand of antenna.

It is always up to the user to determine the appropriate interval for calibration certification based on the requirements of the end user's specific test/application. The calibration of EMC antennas is important for those conforming to compatibility standard. Radiated emissions testing for electromagnetic compatibility (EMC) requires the measurement of electric field (E-field) strength, which is compared with a limit level. The output voltage of an antenna is converted to E-field strength via its antenna factor, the measurement of which must include the uncertainty components related to that particular antenna, taking into consideration the environment in which the antenna is to be used for the testing. Most standards will specify the appropriate interval for re-calibration of your EMC antenna.

In some cases, these antennas are used for a manufacturer's pre-compliance testing, field monitoring, surveillance and/or other applications where the exact field intensity of the received signal is not of importance. For those customers a yearly re-calibration is not necessary, however it is recommended that an interval for maintenance be performed.

For more information about our calibration services or to place an order for antenna calibration visit our website at http://www.AHSystems.com
or call 1(818) 998-0223.