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**PERFORMANCE SPECIFICATION
FOR ANGLE MODULATED RADIO
TRANSMITTERS AND RECEIVERS
FOR USE AS BASE, MOBILE AND
PORTABLE EQUIPMENT
IN THE LAND MOBILE RADIO SERVICE AND
INTENDED PRIMARILY FOR DATA APPLICATIONS**



**TELECOMMUNICATIONS AUTHORITY
HONG KONG**

FOREWORD

1. This specification is prescribed under section 32D of the Telecommunications Ordinance (Cap 106) (“the Ordinance”) to set out the technical and evaluation requirements for angle modulated radio transmitters and receivers operating in the frequency band 30 MHz - 1000 MHz for use as base, mobile and portable equipment in the land mobile radio service and intended primarily for data applications. Radiocommunications apparatus falling into the scope of this specification shall meet the stipulated requirements.
2. Under the Ordinance, the possession or use of any radiocommunications apparatus or any apparatus emitting radio frequency energy must be covered by an appropriate licence issued by the Telecommunications Authority (TA) with the exception of those specifically exempted from licensing under the Ordinance, such as those covered by the Telecommunications (Telecommunications Apparatus)(Exemption from Licensing) Order.
3. At present, the Office of the Telecommunications Authority (OFTA) operates a Hong Kong Telecommunications Equipment Evaluation and Certification (HKTEC) Scheme. Details of the HKTEC Scheme can be found in the information note OFTA I 421. Under the Scheme, suppliers or manufacturers of the radiocommunications apparatus shall apply to OFTA for certification of their apparatus against this specification. The application procedures for certification of radiocommunications apparatus can be found in the information note OFTA I 401.
4. The TA reserves the right to give separate certification to models he considers to be technical variants and the performance of which may differ between models.
5. The TA may amend any part of this specification as and when he deems necessary.
6. In case of doubt about the interpretation of this specification, the methods of carrying out the test and the validity of statements made by the equipment manufacturers or suppliers about the equipment, the decision of the TA shall be final.
7. The HKTA specifications and information notes are issued by the TA. The documents can be obtained through one of the following methods —

- downloading direct through the OFTA's Internet Home Page. The Home Page address is <http://www.ofta.gov.hk>;
- making a request for hard copies to :-

Radio Laboratory,
Standards Section,
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29/F Wu Chung House,
213 Queen's Road East,
Wanchai,
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8. Enquiries about this specification may be directed to —

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1 GENERAL

1.1 Scope of specification

This specification covers the minimum performance requirements for angle modulated radio transmitters and receivers used as base, mobile or portable equipment operating in the frequency band 30 – 1000 MHz for use in the Land Mobile Radio Service and intended primarily for data application.

1.2 Channel spacing requirement

Unless otherwise approved by the Authority, radio equipment operating on frequencies between 30 MHz and 1000 MHz shall follow the channel spacing requirement below:

Operating frequency	Channel spacing
Below 300 MHz	12.5 kHz
300 – 470 MHz	12.5 kHz or 25 kHz
Above 470 MHz	25 kHz

1.3 Transmitter RF power

Whenever the RF power of a radio transmitter is referred to it shall be expressed as the carrier power which is the average power supplied by a transmitter during one radio frequency cycle taken under the condition of no modulation.

For equipment with antenna output terminals the carrier power shall be that supplied from the transmitter output to a matched transmission line connected to the antenna terminals.

For equipment with integral antenna, the carrier power shall mean the effective radiated power in the direction of maximum field strength, i.e. the product of the power supplied to the antenna and its gain relative to a half-wave tuned dipole in the direction of maximum field strength.

The rated carrier power shall be that declared by the manufacturer.

Unless otherwise approved by the Authority, the maximum rated carrier power shall be limited to:

- 25W for base equipment
- 25W for mobile equipment
- 1W for portable equipment

1.4 Operating frequency

Depending on the frequency band applied for, the equipment submitted for type-approval shall be tuned at one or more frequencies as decided by the Authority. Normally, two sets of equipment, one tuned near the front band edge and the other near the rear band edge will be required.

1.5 Type number

The equipment shall be provided with a clear indication of the type-number and description under which it is submitted for type testing. Each type number shall be unique and in the event that the testing authority finds two manufacturers have used a similar type number, the latecomer manufacturer will be asked to use another type number.

1.6 Controls

Those controls, which if maladjusted might increase the interfering potentialities of the equipment, shall not be easily accessible.

1.7 Declarations by the manufacturer

When submitting a equipment for type-approval testing, the manufacturer shall supply a Service Manual complete with drawings of constructional details, circuit diagrams and printed circuit board layout. In addition the following information should be supplied if not recorded in the Manual supplied :

1. nominal frequency of transmitter and of receiver
2. crystal frequency and carrier generation formula

3. crystal type
4. rated carrier power of transmitter
5. continuous or intermittent power rating
6. rated audio output power of receiver
7. nominal supply voltage
8. type of battery
9. battery end point voltage when applicable
10. different operating modes when available (e.g. high and low power modes) and if operation is continuous or is subject to a maximum test duty cycle (e.g. 1 minute on, 4 minutes off)
11. polarization and the reference face of the radiation
12. any temperature stabilization circuit inside the equipment.

2. TEST CONDITIONS: ATMOSPHERIC CONDITIONS AND POWER SUPPLIES

2.1 General

Type-approval test shall be made under normal test conditions and also, where stated, under extreme test conditions.

2.2 Normal test conditions

2.2.1 Atmospheric test conditions

The atmospheric conditions of the test site shall be maintained at any convenient combination of temperature, relative humidity and air pressure within the following ranges:

- | | | | |
|----|-------------------|---|-----------------|
| 1. | Temperature | : | 15°C to 35°C |
| 2. | Relative humidity | : | 10% to 80% |
| 3. | Air pressure | : | 860 to 1060 hPa |

When it is impracticable to carry out the tests under these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, shall be added to test report.

2.2.2 Test power source

2.2.2.1 General

The power supply for the equipment under test may be replaced by a test power source, capable of producing normal and extreme test source voltages as specified below and in 2.3.2 and 2.3.3.

The supply voltage shall be measured at the input terminals of the equipment.

2.2.2.2 Mains test source voltage

For equipment powered by AC mains, 220V $\pm 6\%$ at a frequency of 50 Hz ± 1 Hz shall be designated as the normal test voltage.

2.2.2.3 DC test source voltage

For equipment supplied from self-contained primary cells or batteries or any other DC sources, the normal test source voltage shall be the nominal supply voltage declared by the manufacturer.

2.3 Extreme test conditions

2.3.1 Extreme temperatures

For tests of extreme temperatures, measurements shall be made in accordance with procedures specified in clause 2.4 at an upper value of +55°C and at lower value of -10°C.

2.3.2 Extreme mains test source voltage

The extreme mains test source voltage shall be $\pm 10\%$ of 220V at a frequency of 50 Hz ± 1 Hz.

2.3.3 Extreme DC test source voltage

The extreme DC test source voltage shall be as follows:

1. Regulated lead-acid battery power sources

When the equipment is intended for operation from regulated lead-acid power source, the extreme test source voltages shall be +30% and -10% of the nominal voltage of the battery.

2. Other power sources

When the equipment is intended for operation from power sources using primary batteries, the lower extreme test source voltage shall be as follows:

- a. For Leclanche or Lithium type of battery, it shall be 15% below the nominal voltage.
- b. For Mercury or Nickel-Cadmium type of battery, it shall be 10% below the nominal voltage.
- c. For other types of battery, it shall be the end point voltage declared by the equipment manufacturer.

No upper extreme test voltage shall apply for radio equipment designed for battery-only use.

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test source voltages shall be those agreed between the equipment manufacturer and testing authority and shall be recorded with the test results.

2.4 Procedures for tests at extreme temperatures

2.4.1 General

Before making measurements, the equipment, which is switched off, shall be placed in a temperature controlled chamber for a period of one hour for temperature stabilization. The humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

2.4.2 Equipment designed for continuous operation

For tests at the upper temperature, after temperature stabilization in accordance with clause 2.4.1, the equipment shall be switched on in the transmit condition for half an hour, after which the appropriate tests shall be carried out. For tests at the lower temperature, after temperature stabilization in accordance with clause 2.4.1, the equipment shall be switched on in the receive or transmit condition for one minute, after which the appropriate tests shall be carried out. (Note: In any test, if the equipment contains temperature stabilization circuits designed to operate continuously, the equipment shall be switched on for 15 minutes before measurements are made).

2.4.3 Equipment designed for intermittent operation only

The procedure shall be as described in clause 2.4.2, except that at the upper temperature, the half hour transmit condition shall be replaced by one minute in the transmit condition followed by four minutes in the receive condition before measurements are made.

3. ELECTRICAL TEST CONDITIONS

3.1 Normal test signal

When the equipment is designed to transmit continuous bit streams, the normal test signal shall consist of a pseudo-random bit sequence of at least 511 bits according to ITU-T Recommendation O.153. If the transmission of a continuous bit stream is not possible, the normal test signal shall be trains of correctly coded bits or messages. This signal shall be one that requires the greatest radio frequency occupied bandwidth, as agreed between the manufacturers and the TA.

3.2 Transmitter loading conditions

The transmitter antenna output shall be terminated with a non-reactive, non-radiating load with nominal impedance of 50 ohms. In case the nominal impedance is of value other than 50 ohms, the manufacturer shall provide suitable matching devices for type-approval purpose.

3.3 Receiver input signal

Test signals applied to the receiver input terminals shall be connected in such a way that the source impedance seen from the receiver input terminals equals to the nominal input impedance of the receiver, and the load impedance seen by each generator also equals to the nominal input impedance of the receiver.

The levels of the test signals shall be expressed in terms of the potential difference at the input terminals of the receiver.

The effects of any intermodulation products and noise produced in the signal generators shall be negligible.

3.4 Receiver mute or squelch facility

If the receiver is equipped with a mute or squelch circuit, this shall be made inoperative for the duration of type-approval test except otherwise stated in this specification.

3.5 General requirements for tests involving the use of radiated fields

All radiated measurement should be carried out at a test site as specified in CISPR 16-1, "Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus" issued by the International Electrotechnical Commission. Test sites including fully Anechoic chamber, an Anechoic chamber with ground plate and Open Area Test Site (OATS) shall be considered acceptable if the horizontal and vertical site attenuation measurements are within ± 4 dB of the theoretical site attenuation for an ideal free field test site. The performance of the test site shall be verified before conducting any radiated measurement at the test site.

If the radiated measurement is carried out at a fully Anechoic Chamber or an Anechoic Chamber with ground plate, the separation distance between the centre of the vertical projection of the equipment under test (EUT) (i.e. the test sample) in the horizontal plane and the centre of the test antenna shall be at least 3 m and adequate to allow for radiated measurement in the far field of the EUT.

Unless otherwise specified, all radiated measurements should follow the general arrangements as specified in the relevant clause of ETSI EN 300 113-1 and ETSI EN 300 390-1 issued by the European Telecommunications Standards Institute (ETSI).

4. TEST FOR TRANSMITTER PART

4.1 Carrier power

4.1.1 Definition

The carrier power is the average power during one radio frequency cycle in the absence of modulation. The rated carrier power is the carrier power of the equipment as declared by the manufacturer.

For equipment with antenna output terminals, the carrier power is that available at the output terminals when they are connected to the nominal load condition specified by the manufacturer.

For equipment with integral antenna, the carrier power is the effective radiated power in the direction of maximum field strength.

4.1.2 Test method

The carrier power shall be obtained in accordance with the test methods as stipulated in the relevant clause of HKTA 1046. Alternatively, measurement in accordance with ETSI EN 300 113-1 and ETSI EN 300 390-1 will also be acceptable.

The measurement shall be made under normal test conditions (clause 2.2) and repeated under extreme test conditions (clause 2.3).

4.1.3 Limits

The carrier power shall be within ± 1.5 dB of the rated carrier power under normal test conditions, and within ± 2 dB of the rated carrier power under extreme test conditions. These limits apply to transmitters with or without integral antenna.

4.2 Frequency error

4.2.1 Definition

The frequency error of the transmitter is the difference between the unmodulated carrier frequency and the nominal frequency.

4.2.2 Test method

The frequency error shall be obtained in accordance with the test methods as stipulated in the relevant clause of HKTA 1046. Alternatively, measurement in accordance with ETSI EN 300 113-1 and ETSI EN 300 390-1 will also be acceptable.

The measurement shall be made under normal test conditions (clause 2.2) and repeated under extreme test conditions (clause 2.3).

4.2.3 Limits

The frequency error under both normal and extreme test conditions shall not exceed the values given below:

Frequency Band	Frequency Tolerance
Below 108 MHz	12 PPM
108 – 400 MHz	5 PPM
400 – 470 MHz	5 PPM for 25 kHz channel spacing; 3 PPM for 12.5 kHz channel spacing
Above 470 MHz	2.5 PPM for 25 kHz channel spacing; 1.5 PPM for 12.5 kHz channel spacing

4.3 Adjacent channel power

4.3.1 Definition

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation, which falls within a specified bandwidth centered on the nominal frequency of either of the adjacent channel. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

The adjacent channel power shall be measured with a power measuring receiver, which conforms to the requirements given in ETSI EN 300 113-1 or ETSI EN 300 390-1.

4.3.2 Test method

The adjacent channel power shall be obtained in accordance with the test methods as stipulated in the relevant clause of ETSI EN 300 113-1 and ETSI EN 300 390-1.

4.3.3 Limits

For a channel separation of 25 kHz the adjacent channel power shall not exceed a value of 65 dB below the carrier power of the transmitter, and for a channel separation of 12.5 kHz it shall not exceed 55 dB below the carrier power of the transmitter. In either case there is no need for the adjacent channel power to be below 0.2 μ W.

4.4 Spurious emissions

4.4.1 Definition

Spurious emissions are emissions at frequencies other than those of the carrier and sidebands associated with normal modulation resulting from signals generated within the equipment.

For equipment with antenna output terminals, the level of spurious emissions shall be measured as :

1. the power level delivered from the transmitter output into a specified load (e.g. transmission line or antenna), which is also known as conducted spurious emissions, and
2. the effective radiated power when radiated by the cabinet and structure of the equipment, which is also known as cabinet radiation.

For equipment incorporating integral antenna, the level of spurious emissions shall be measured as their effective radiated power when radiated by integral antenna and cabinet of the equipment.

4.4.2 Test method

For measuring the conducted spurious emission of equipment with antenna output terminals, the measuring receiver shall be tuned over the frequency range from 100 kHz to 1000 MHz, or four times the working frequency, whichever is the greater. For measuring effective radiated power of equipment with integral antenna, the measurement shall be repeated at all spurious response frequencies found during the search over the limited frequency range from 30 MHz to 1000 MHz, or four times the working frequency, whichever is the greater. The spurious emissions shall then be obtained in accordance with the test methods as stipulated in the relevant clause of HKTA 1046. Alternatively, measurement in accordance with ETSI EN 300 113-1 and ETSI EN 300 390-1 will also be acceptable.

4.4.3 Limits

The power of any spurious emission, whether measured as output power level at the antenna terminals or effective radiated power in free space in the specified range of frequencies at either plane of polarization, shall not exceed 2.5 μ W (-26 dBm).

5. TEST FOR RECEIVER PART

5.1 Usable sensitivity

5.1.1 Definition

For equipment with antenna terminals, the maximum usable sensitivity (conducted) of the receiver is the minimum level of signal (e.m.f.) at the receiver input, produced by a carrier at the nominal frequency of the receiver, modulated with a normal test signal, which will, without interference, produce after modulation a data signal with:

- a bit error ratio of 10^{-2} or
- a successful message ratio of 80%.

For equipment with integral antenna, the average usable sensitivity (field strength) of the receiver is the minimum field strength at the location of the receiver, at the nominal frequency of the receiver and with normal test signal which produces a signal at the receiver output as mentioned above.

5.1.2 Test method

The maximum / average usable sensitivity of a receiver shall be obtained in accordance with the test methods as stipulated in the relevant clause of ETSI EN 300 113-1 and ETSI EN 300 390-1.

The measurement shall be made under normal test conditions (clause 2.2) and repeated under extreme test conditions (clause 2.3).

5.1.3 Limits

For equipment with antenna terminals, the maximum usable sensitivity shall not exceed 3 dB μ V (e.m.f.) under normal test conditions, and 9 dB μ V (e.m.f.) under extreme test conditions.

For equipment with integral antenna, the average usable field strength sensitivity shall not exceed 26 dB μ V/m under normal test conditions and 32 dB μ V/m under extreme conditions.

5.2 Adjacent channel selectivity

5.2.1 Definition

The adjacent channel selectivity is a measurement of the equipment capability to receive the wanted modulated signal at the assigned carrier frequency in the presence of the unwanted modulated signal which differs by one channel spacing.

5.2.2 Test method for equipment with antenna output terminals

The upper and lower adjacent channel selectivity shall be obtained in accordance with the test methods as stipulated in the relevant clause of ETSI EN 300 113-1 under normal test conditions (clause 2.2) and repeated under extreme test conditions (clause 2.3).

5.2.3 Test method for equipment with integral antenna

The upper and lower adjacent channel selectivity shall be obtained in accordance with the test methods as stipulated in relevant clause of ETSI EN 300 390-1 under normal test conditions (clause 2.2) and repeated under extreme test conditions (clause 2.3).

5.2.4 Limits

For a channel separation of 25 kHz, the adjacent channel selectivity shall be not less than 70 dB under normal test conditions and not less than 60 dB under extreme test conditions.

For a channel separation of 12.5 kHz, the adjacent channel selectivity shall be not less than 60 dB under normal conditions, and not less than 50 dB under extreme test conditions.

For equipment with integral antenna, the field strength obtained in the measurement of adjacent channel selectivity shall be not less than the following limit:

Frequency band	Normal conditions	Extreme conditions
66-87 MHz	64 dB μ V/m	54 dB μ V/m
137-174 MHz	70 dB μ V/m	60 dB μ V/m
350-550 MHz	90 dB μ V/m	80 dB μ V/m

5.3 Intermodulation response rejection

5.3.1 Definition

The intermodulation response rejection is a measure of the capability of a receiver to receive wanted modulated signal, without exceeding a given degradation due to the presence of two or more signals at unwanted signals with a specific frequency relationship to the wanted signal frequency. The intermodulation response rejection ratio is the ratio in dB of the levels of the unwanted and wanted signals when a bit error ratio of 10^{-2} or a successful message ratio of 80% is obtained.

5.3.2 Test method

The intermodulation response rejection shall be measured in accordance with the test methods as stipulated in the relevant clause of ETSI EN 300 113-1 and ETSI EN 300 390-1.

5.3.3 Limits

For equipment with antenna terminal the intermodulation response rejection ratio shall not be less than 65 dB for base and 60 dB for mobile and portable equipment.

For equipment with integral antenna the field strength obtained in the measurement shall be not less than the value given below:

Frequency band	Intermodulation strength
66-87 MHz	64 dB μ V/m
137-174 MHz	70 dB μ V/m
350-550 MHz	80 dB μ V/m

5.4 Blocking or desensitization

5.4.1 Definition

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequencies other than those of the spurious responses or the adjacent channels. The given degradation is either a bit error ratio of 10^{-2} or a successful message ratio of 80%.

5.4.2 Test method

The blocking or desensitization shall be obtained in accordance with the test methods as stipulated in the relevant clause of ETSI EN 300 113-1 and ETSI EN 300 390-1.

5.4.3 Limits

The blocking ratio at any frequency within the specified range shall be not less than 84 dB at the input of the receiver, except at frequencies on which spurious responses are found.

For equipment with integral antenna, the field strength obtained in the measurement shall not be less than the value given below:

Frequency band	Performance limit
66-87 MHz	89 dB μ V/m
137-174 MHz	95 dB μ V/m
350-550 MHz	103 dB μ V/m

5.5 Spurious response rejection

5.5.1 Definition

The spurious response rejection is a measure of the capability of the receiver to discriminate between a wanted modulated signal at the nominal frequency and an unwanted signal at any other frequency. The spurious response rejection ratio is the ratio in dB of the levels of the unwanted and wanted signals when a bit error ratio of 10^{-2} or a successful message ratio of 80% is obtained.

5.5.2 Test method

The spurious response rejection shall be obtained in accordance with the test methods as stipulated in the relevant clause of ETSI EN 300 113-1 and ETSI EN 300 390-1.

5.5.3 Limits

At any frequency separated from the nominal frequency of the receiver by more than one channel spacing, the spurious response rejection ratio shall not be less than 70 dB for base and not less than 65 dB for mobile and portable equipment.

For equipment with integral antenna the field strength obtained in the measurement shall not be less than the value given below:

Frequency band	Spurious strength
66-87 MHz	64 dB μ V/m
137-174 MHz	70 dB μ V/m
350-550 MHz	80 dB μ V/m

5.6 Receiver spurious emissions

5.6.1 Definition

Spurious emissions from receivers are any emissions present at the antenna terminals of the equipment or radiated from the cabinet and structure of the receiver (which is also known as receiver cabinet radiation).

5.6.2 Test method

For measuring the conducted spurious emission of equipment with antenna terminals, the measuring receiver shall be tuned over the frequency range from 100 kHz to 1000 MHz, or four times the working frequency, whichever is the greater. For measuring effective radiated power of equipment with integral antenna, the measurement shall be repeated at all spurious response frequencies found during the search over the limited frequency range from 30 MHz to 1000 MHz, or four times the working frequency, whichever is the greater. The receiver spurious emissions shall then be obtained in accordance with the test methods as stipulated in the relevant clause of ETSI EN 300 113-1 and ETSI EN 300 390-1.

5.6.3 Limits

The power of any spurious emission whether measured as output power level at the antenna terminals or effective radiated power in free space shall not exceed 20 nW.

6. ACCURACY OF MEASUREMENT

The absolute allowable 95% confidence level measurement uncertainties for the measurements included in this document shall not exceed the values stated below:

(Valid up to 1 GHz for the RF parameters unless otherwise stated)

RF frequency	1 x 10 ⁻⁶
Radiated RF power	6 dB
Conducted RF power variations using a test fixture	0.75 dB
Maximum frequency deviation:	
- within 300 Hz to 6 kHz of audio frequency	5 %
- within 6 kHz to 25 kHz of audio frequency	3 dB
Deviation limitation	5 %
Adjacent channel power	5 dB
Conducted emission of transmitter, valid to 4GHz	4 dB
Conducted emission of transmitter (cabinet radiation), valid to 4GHz	6 dB
Audio output power	0.5 dB
Conducted emission of receiver	4 dB
Conducted emission of receiver (cabinet radiation), valid to 4GHz	6 dB
Two-signal measurement, valid to 4GHz (using a test fixture)	4 dB
Two-signal measurements using radiated fields	6 dB
Three-signal measurement (using a test fixture)	3 dB
Radiated emission of transmitter, valid to 4GHz	6 dB
Radiated emission of receiver, valid to 4GHz	6 dB

7. REFERENCE

CISPR 16-1 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 1 Radio disturbance and immunity measuring apparatus”

HKTA 1046 "Method of Measurement for Radio Transmitter for Use in the Land Mobile Service"

ETSI EN 300 113-1 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment intended for the transmission of data (and speech) and having an antenna connector; Part 1 Technical characteristics and methods of measurement”

ETSI EN 300 390-1 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment intended for the transmission of data (and speech) and using an integral antenna; Part 1 Technical characteristics and methods of measurement”

ITU-R Recommendation M.478 “Technical characteristics of equipment and principles governing the allocation of frequency channels between 25 and 3000 MHz for the FM land mobile service”

ITU-R Recommendation SM.1045 “Frequency tolerance of transmitters”

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