Russian National Primary Standard Facility for realization of lightning impulse current unit

K.Yu. Sakharov, V.A. Turkin, O.V. Mikheev, A.V. Sukhov
All-Russian Research Institute for Optical and Physical Measurements (VNIIOFI)
Moscow, Russia
m12@vniiofi.ru

***Abstract* – The description of the National Primary Standard Facility of lightning impulse current unit, its operation principles and the results of its experimental characterization are presented. The current pulses in the amplitude range from 1 to 100 kA with minimal rise time 140 ns are generated in the standard facility. The expanded uncertainty of the realization of the lightning impulse current unit (P = 0.99) is no more than 2.6%.**

Keywords – lightning, impulse current, standard facility, calibration

I. Introduction

It is important to monitor a waveform (amplitude and time characteristics) of the current pulses generated in the simulators during lightning immunity testing of the aerospace vehicles, power systems and communication devices. There are different types of the measuring instruments (MI) used for this purpose (EM 8.4.5 and EM 8.4.6 in accordance with BIMP classification). The development of the standard facility of lightning impulse current solved the problem of calibration of such MI [1].

II. The Standard Facility Construction

The lightning impulse current waveform is normalized in the standards. The amplitude of component A is 200 kA with the rise time $t_R \approx$ 2-5 μs (according to various sources, for example [1, 2]). Consequently the reference current pulses for the MI calibration must have the rise time no more than t_R = 2/3 ≈ ≈ 0.7 μs at the amplitude I_A of order 100 kA (since usually the MI dynamic range is more than 2). These statements formed the basis of the standard facility development.

Figure 1. Standard facility for realization of lightning impulse current unit

The standard facility includes the following devices (Fig.1): high-voltage pulse generator (HVPG) consisting of the capacitive storage *1*, high-voltage gas-filled gap *2* and the unit of the discharge resistance *3*; single-turn high impulse current transformer *4*; output terminals *5* and current shunts *6*. Noninductive coaxial shunts are made of the manganin foil and they are used for the determination of the generated pulse waveform parameters.

There are two operating modes in the standard facility. In the first mode the capacitive storage is directly discharged on the output terminals. At the same time the small amplitude current pulse with the short rise time is generated to determine the transient response rise time of calibrated MI. In the second mode the storage discharges through the high impulse current transformer and the current pulse with the amplitude up to 100 kA is generated to determine the conversion ratio of the MI.

III. Facility Characterization Results

The results of standard facility experimental characterization are presented in table 1. The typical oscillograms of the current pulses generated in the standard facility are presented on the Fig. 2 (the voltage-current re-calculation has been made taking into account the shunt conversion ratios).

TABLE I. Metrological Characteristics of the Standard Facility

Op. mode	Amplitude I_A, kA	Rise time t_R, μs	Duration t_P, μs
I	1.0÷8.0	0.14÷0.4	10÷12
II	6.0÷100	9.2÷10.0	35÷36

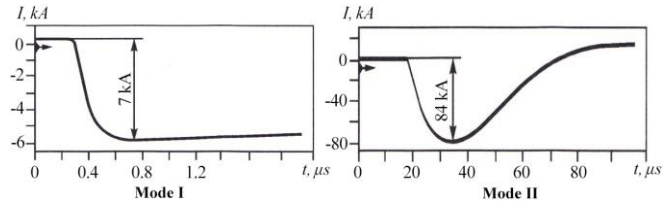

Figure 2. The typical oscillograms of the generated current pulses

The expanded uncertainty of the realization of the lightning impulse current unit (P = 0.99) is no more than 2.6%

References

[1] Gamerota, W.R. et al. "Current Waveforms for Lightning Simulation", Electromagnetic Compatibility, IEEE Transactions on, pp. 235-238, Vol. 54, Issue 4, Aug. 2012

[2] Aviation Rules AP-25. Interstate Aviation Committee. OAO "Aviaizdat", 2004.

[3] K.Yu. Sakharov, V.A. Turkin, O.V. Mikheev, A.V. Sukhov. National Primary Standard of lightning pulse current unit at the range from 1 up to 100 kA // Measurement Techniques, 56, No 11, 1203-1208 (2014)