X-BAND TE_{10}-TE_{01} MODE CONVERTERS

S.Yu.Kazakov
142248, Branch of Budker Institute of Nuclear Physics,
Protvino,Moscow reg.,Russia

Abstract

The three X-band compact TE_{10}-TE_{01} Mode Converters with passband and electric field strength enough for linear accelerator using are described.

INTRODUCTION

The systems of RF feeding for the future high gradient linear accelerator probably will use the TE_{01} mode of wave in circular waveguide. TE_{01} mode has two important properties: the absence of electric field on the wall of waveguide and the low propagation losses. The first one can be used for creation of windows for powerful RF sources [1] , the second property is useful for RF power doubling systems [2,3]. But klystron RF sources and accelerating structures utilize the rectangular waveguides with TE_{10} mode, so TE_{10}-TE_{01} Mode Converters (MC) is necessary. Of course, it is desirable to have compact and cheep converters. One of them, Flower-Petal MC, is under investigation in SLAC [4]. In this article the three other type of compact MC are described.

PRINCIPLE OF OPERATION

The basic operation principle of described MC is symmetry. All MCs include a thick diaphragm which consist of four sector waveguides (Fig.1). If these waveguides are excited the equal way with the same amplitudes and phases, they, in their turn, will excite the pure TE_{01} mode of wave in circular waveguide (diameter of waveguide is smaller than TE_{41} cut-off diameter). The described MCs are distinguished from each to other by excitation way of sector waveguides.

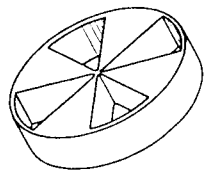

Fig1. Four sector waveguide diaphragm

MODE CONVERTER #1

In the MC #1 the sector waveguides are excited by two coupling holes which link the rectangular waveguide with the circular one. The holes are located at half-wave distance in rectangular waveguide, so holes should be excited with equal amplitudes and opposite phases. It is clear from Fig.2, if fields in holes have equal amplitude and opposite phases, the sector waveguides will be excited the desirable way and after them shall exist pure TE_{01} mode.

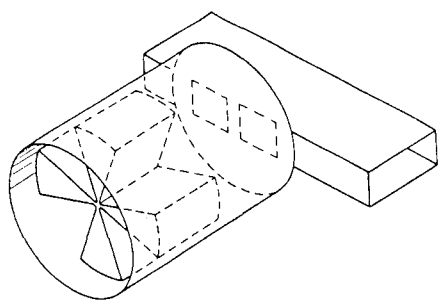

Fig.2 Mode Converter #1

Two MC of this type were made for high power use. Fig.3 demonstrates SWR vs frequency. Low power test shows that energy purity of TE_{01} mode after conversion is more than 99%. Fig.4 demonstrates the SWR of two MC connected through circular waveguide for several different angular positions of one MC from other. The MC are intended to test at high power in nearest future in KEK(Japan).

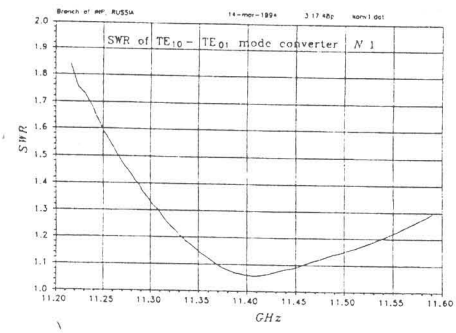

Fig.3 SWR of MC #1 vs frequency

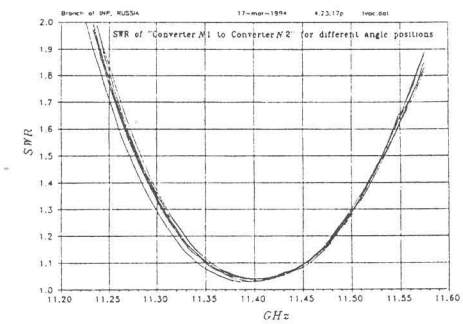

Fig.4 SWRs vs frequency of two MC #1 connected through circular waveguide for different angular positions.

MODE CONVERTER #2

MC #2 utilizes the TE_{20} mode of rectangular waveguide to excite the sector waveguides. TE_{20} mode is produced by E-plain T-junction . Fig.5 shows the MC as whole and Fig.6 demonstrates S-parameters calculated by HFSS code. It is clear from Fig.6 that it is possible to make MC with passband enough for LINAC purposes. The simulated energy purity is close to 100%.

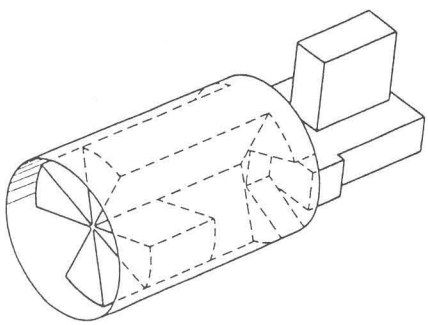

Fig.5 Mode Converter #2

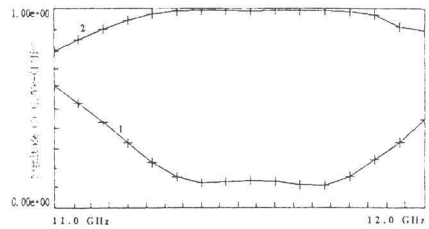

Fig.6 S-parameters of MC #2 calculated by HFSS . Curve 1 is reflected TE_{10} wave. Curve 2 is transmitted TE_{01} wave.

MODE CONVERTER #3

In MC #3 the two additional sector waveguides are used for excitation of the four ones. These two waveguides are excited by rectangular one directly. The Fig.7 shows the MC #3. For matching the diaphragm was added in circular waveguide. The model of MC for low power test was made. The 230 MHz passband (SWR<1.21) was measured. Purity is more than 99%.

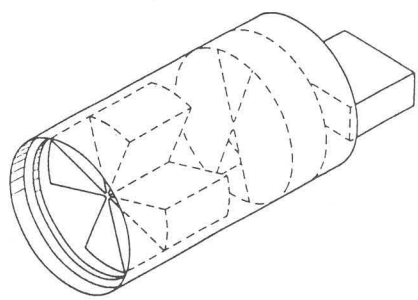

Fig.7 Mode Converter #3

ELECTRIC FIELD STRENGTH

The analysis of E-field strength was made by means of HFSS. Table 1 summarizes the results of analysis. For comparison the coupling slot of Flower-Petal MC was simulated too. In all cases the radii of sharp edges were chosen as 1 mm.

Table 1.
Maximum of electric field strength on the surface corresponding to 100 MW transmitted power

Flower-Petal	740 kV/cm
MC #1	680 kV/cm
MC #2	370 kV/cm
MC #3	-------

CONCLUSIONS

The three type of compact TE_{10}-TE_{01} Mode Converters with passband,electric field strength and purity enough for linear accelerator purposes are developed.

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