4 and 9 GHz are plotted in Figure 8. We can see that the radiation patterns in the H-plane are nearly omnidirectional.

4. CONCLUSIONS

In this letter, a novel compact microstrip-fed monopole antenna with a total size of 12 mm × 17 mm × 1.6 mm for UWB application has been presented. By using two quarter circles at each lower corner of the radiation patch and adding a notch in the ground plane, the impedance bandwidth can be enhanced to 4.9:1(3.0–14.7 GHz). In addition, the proposed antenna shows omnidirecional radiation pattern through the whole operation band, and is simple to be fabricated at a low cost. It is easy to be implemented in today's wireless communication terminals, which make it a good candidate for UWB applications.

REFERENCES

1. W. Hirt, Ultra-wideband radio technology: Potential and challenges ahead, IEEE Commun Mag (2003), 66–74.
2. J. Jung, W. Choi, and J. Choi, A small wideband microstrip-fed monopole antenna, IEEE Antenna Wireless Propag Lett 15 (2005), 703–705.
3. W.-P. Lin and C.-H. Huang, Coplanar waveguide-fed rectangular antenna with an inverted-L stub for ultrawideband communications, IEEE Antenna Wirel Propag Lett 8 (2009), 228–231.
4. M.O. Jaroudi, C. Ghobadi, and J. Nourinia, Small square monopole antenna with inverted T-shaped notch in the ground plane for UWB application, IEEE Antenna Wirel Propag Lett 15 (2005), 703–705.
5. R. Zaker, C. Ghobadi, and J. Nourinia, Novel modified UWB planar monopole antenna with variable frequency band-notch function, IEEE Antenna Wirel Propag Lett 7 (2008), 112–114.
6. C.-Y.-D. Sim, W.-T. Chung, and C.-H. Lee, A circular-disc monopole antenna with band rejection function for ultrawideband application, Microwave Opt Technol Lett 51 (2009), 1607–1613.
7. M.N. Moghadasi, H. Rousta, and B.S. Virdee, A highly compact semieliptic shape ultrawideband monopole antenna, Microwave Opt Technol Lett 53 (2011), 229–231.
8. Ansoft Corp. Ansoft High Frequency Structure Simulation (HFSS). Ver. 11, Ansoft Corp., Pittsburgh, PA, 2009.
9. J.L. Volakis, Antenna engineering handbook, McGraw-Hill, New York, NY, 2007.

WIDEBAND QUASI-YAGI ANTENNA FED BY MICROSTRIP-TO-SLOTLINE TRANSITION

Son Xuat Ta,[1] Byoungchul Kim,[1] Hosung Choo,[2] and Ikmo Park[1]
[1] School of Electrical and Computer Engineering, Ajou University, 5 Woncheon-dong, Youngtong-gu, Suwon 443-749, Korea; Corresponding author: ipark@ajou.ac.kr
[2] School of Electronic and Electrical Engineering, Hongik University, 72-1 Sangsu-dong, Mapo-gu, Seoul 121-791, Korea

Received 19 March 2011

ABSTRACT: *This letter presents a wideband quasi-Yagi antenna fed by a microstrip-to-slotline transition. The transition consists of a microstrip radial stub and slot radial stub, both at 90° but with different radii, to achieve wideband impedance matching. The antenna has a measured fractional bandwidth of approximately 46% (4.64–7.42 GHz) for a −10 dB reflection coefficient and a flat gain of 6.0–6.75 dBi with a front-to-back ratio and cross-polarization level better than 17 and −15 dB, respectively, across the bandwidth.* © 2011 Wiley Periodicals, Inc.
Microwave Opt Technol Lett 54:150–153, 2012; View this article online at wileyonlinelibrary.com. DOI 10.1002/mop.26504

Key words: *quasi-Yagi antenna; wideband antenna; slotline transition*

1. INTRODUCTION

Quasi-Yagi antennas have attracted much attention for use in microwave and millimeter-wave applications because of their broad bandwidth, high gain, low profile, uniplanar structure, ease of fabrication, and low cost. However, these antennas require a transition between the feed line and driver because of the nature of the feed structure. Kaneda et al. described a quasi-Yagi antenna fed by a microstripline-to-coplanar stripline (MS-to-CPS) transition [1, 2]. This transition introduced a phase delay of 180° between two MS branches by adjusting their length. However, this transition produced only a stable radiation pattern of the antenna near the center frequency of operation. Woo et al. reported another quasi-Yagi antenna that used an MS-to-CPS balun feed [3]. The balun consisted of several vias to maintain the same ground-plane potential across the substrate. Truong et al. presented a coplanar waveguide-to-CPS (CPW-to-CPS) transformer-fed quasi-Yagi antenna on a GaAs substrate for the 94-GHz band [4]. The transformer incorporated air bridges to suppress multimode propagation along the signal paths by equalizing the ground potential on both sides of the CPW. These antennas with vias or air bridges have the common disadvantage of a complex design and fabrication topology. Zheng et al. [5] presented a quasi-Yagi antenna with a driver, which is fed by two parallel strips printed on opposite sides of the substrate. Kan et al. [6] introduced a CPW-fed quasi-Yagi antenna, in which one side of the driver was connected to the central strip and the other was connected to the ground. These MS-fed or CPW-fed antennas have a fairly simple feed structure, but the asymmetric nature of the antenna degrades the radiation patterns. Han et al. [7] presented a quasi-Yagi antenna with a simple CPS feed that affords greater design flexibility than other quasi-Yagi antennas in terms of arranging the reflectors for improving the radiation patterns and gain variations throughout the bandwidth. However, the antenna was not suitable for array applications because of the feed structure.

This letter introduces a quasi-Yagi antenna fed by a microstrip-to-slotline transition. The antenna has a wide bandwidth (4.64–7.42 GHz with a reflection coefficient less than −10 dB) and a nearly flat gain (6.0–6.75 dBi). The transition consists of a microstrip radial stub and slot radial stub, both at 90° but with different radii [8]. The antenna incorporates a parasitic strip as a director and a truncated ground plane as the reflector to achieve minimum variation in the gain across the operating bandwidth.

2. ANTENNA STRUCTURE AND CHARACTERISTICS

Figure 1 shows the geometry of this wideband antenna, which was designed for construction on a 50 mm × 60 mm RT/Duroid 6010 substrate with a dielectric constant ε_r of 10.2 and thickness of 0.635 mm. The antenna was composed of a microstrip-to-slotline transition feed, driver, parasitic strip element as a director, and truncated ground plane as a reflector. The driver was directly connected to the slotline with a CPS. The MS of the transition was situated at the posterior of the substrate. The MS had a characteristic impedance of 50 Ω, whereas the slotline had a characteristic impedance of approximately 80 Ω. A microstrip radial stub and slot radial stub, both at 90° but with different radii, were inserted in the transition to improve the impedance matching.

A full-wave electromagnetic (EM) simulator (Microwave Studio, Computer Simulation Technology) was used to design this antenna. From the EM simulation, the lengths of the driver

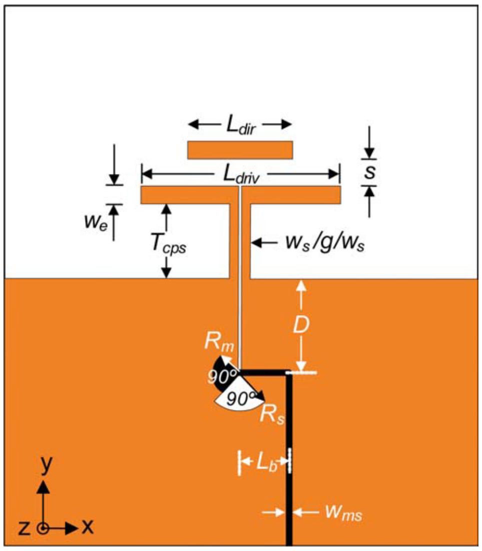

Figure 1 Antenna geometry. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

(L_{driv}) and director (L_{dir}) were found to mainly determine the lower and higher resonances of the antenna, respectively, and the effect of these lengths on the changes in the reflection coef-

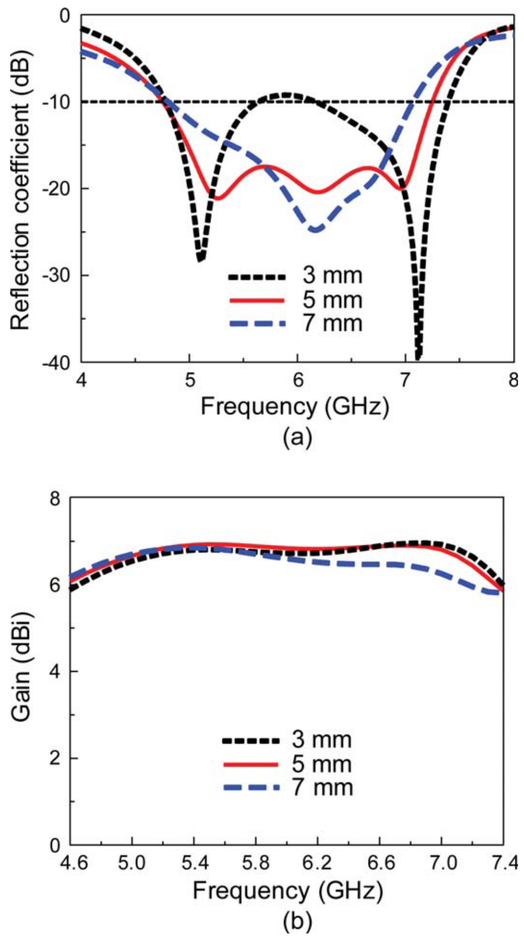

Figure 2 Characteristics of antenna as a function of length of coplanar stripline (T_{cps}): (a) reflection coefficient and (b) gain. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

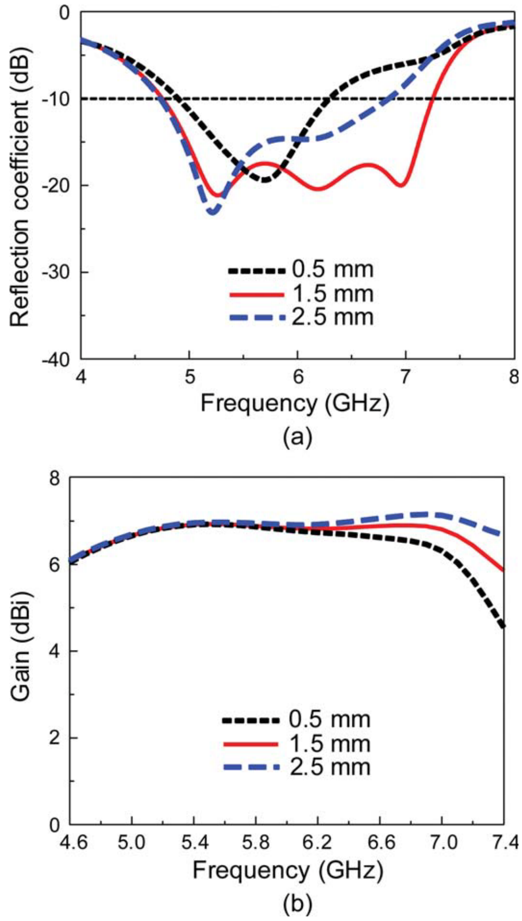

Figure 3 Characteristic of antenna as a function of space between driver and director (s): (a) reflection coefficient and (b) gain. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

ficient is significant but the antenna gain variation is negligible. Figure 2 shows the antenna characteristics as functions of the length of the CPS (T_{cps}). Increments of 2 mm of this length from 3 to 7 mm induced significant changes in the reflection coefficient but small changes in the gain. From the figure, we can see that when the length of the CPS is approximately a quarter wavelength at the center frequency (5 mm at 6 GHz), optimum results in terms of the reflection coefficient and gain

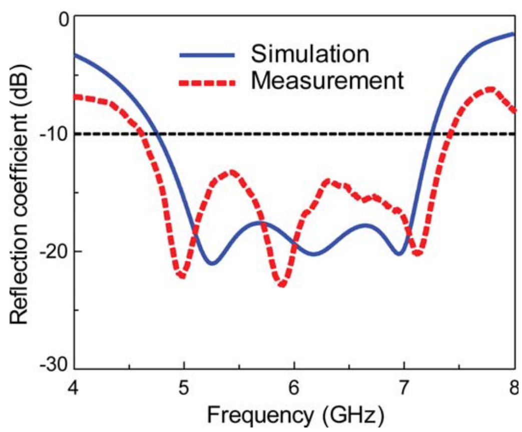

Figure 4 Reflection coefficient of the antenna. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

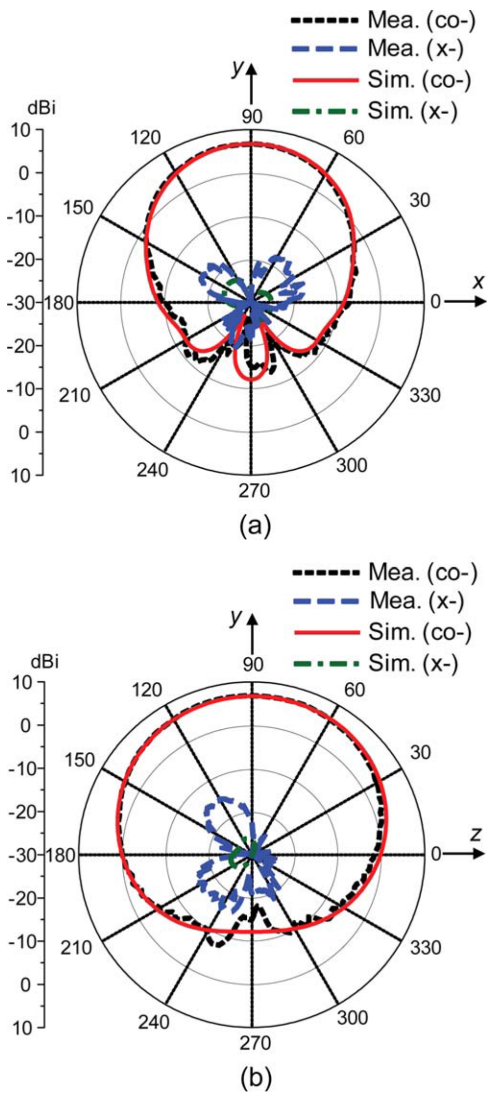

Figure 5 Radiation patterns at 5 GHz: (a) E-plane and (b) H-plane. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

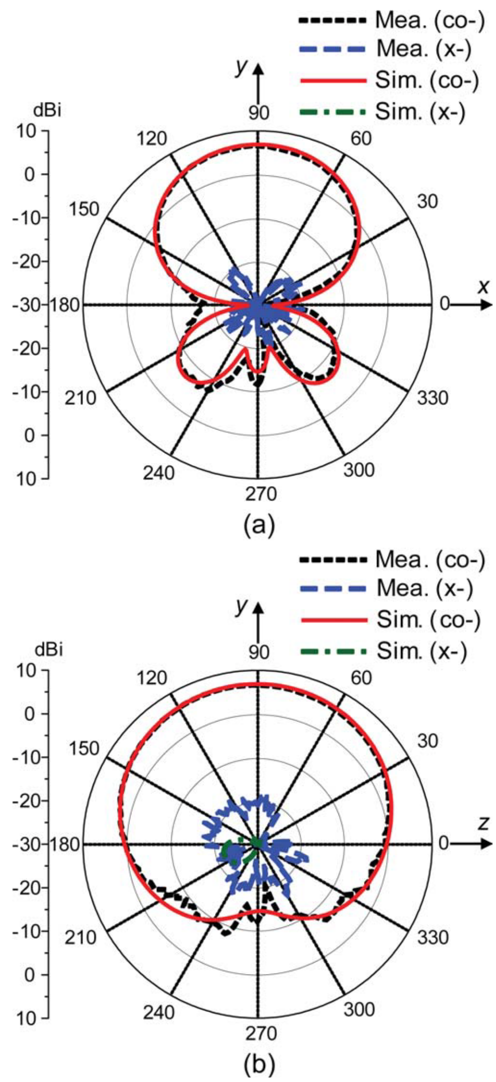

Figure 6 Radiation patterns at 6 GHz: (a) E-plane and (b) H-plane. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

are obtained. The variations in the antenna characteristics as a function of the space between the driver and the director (s) are shown in Figure 3. Increments of 1 mm of this space from 0.5 to 2.5 mm induced significant changes in the reflection coefficient and gain in the high-frequency region but negligible changes in the low-frequency region. This indicates that the space between the driver and the director mainly affects the antenna characteristics in the high-frequency region. It also shows that the space between the driver and the director is very important in obtaining the minimum gain variation within the impedance bandwidth. The optimized antenna design parameters chosen to provide a wide bandwidth with minimum gain variation were $D = 10$ mm, $L_{\mathrm{driv}} = 15$ mm, $L_{\mathrm{dir}} = 9$ mm, $w_{\mathrm{e}} = 1.8$ mm, $s = 1.5$ mm, $g = 0.3$ mm, $w_{\mathrm{s}} = 0.8$ mm, $R_{\mathrm{s}} = 4$ mm, $w_{\mathrm{ms}} = 0.56$ mm, $R_{\mathrm{ms}} = 2.8$ mm, $L_{\mathrm{b}} = 5$ mm, and $T = 5$ mm.

The antenna was fabricated by standard etching on both sides of an RT/Duroid 6010 substrate. An Agilent N5230A network analyzer was used for the measurements of the prototype. As shown in Figure 4, the simulated and measured reflection coefficients of the optimized antenna were in close agreement. The measured bandwidth for the -10 dB reflection coefficient was 4.64–7.42 GHz, whereas the simulated bandwidth was 4.74–7.25 GHz. The slight difference between the two was due to a misalignment at the transition and the effect of the subminiature version A connector.

The antenna radiation patterns in the E- and H-planes were measured at 5, 6, and 7 GHz, as shown in Figures 5–7, respectively, where it can be observed that the measured patterns are in close agreement with the simulated patterns. The measured half-power beam width (HPBW) was in the range of 73.0–76.0° in the E-plane and 128.0–131.0° in the H-plane, whereas the simulated HPBW was in the range of 68.4–73.1° in the E-plane and 123.3–129.1° in the H-plane. These measurements also demonstrated a stable radiation pattern with a front-to-back ratio and cross-polarization level better than 17 and -15 dB, respectively. As shown in Figure 8, the measured gain of the antenna was 6.0–6.75 dBi across the operating bandwidth; this was in close agreement with the simulated gain of 6.25–6.93 dBi. The antenna exhibited a very small gain variation across its bandwidth; the measured and simulated gain variations were only 0.75 and 0.68 dB, respectively. Therefore, the antenna is stable for transmitting and receiving applications in wideband wireless communication systems.

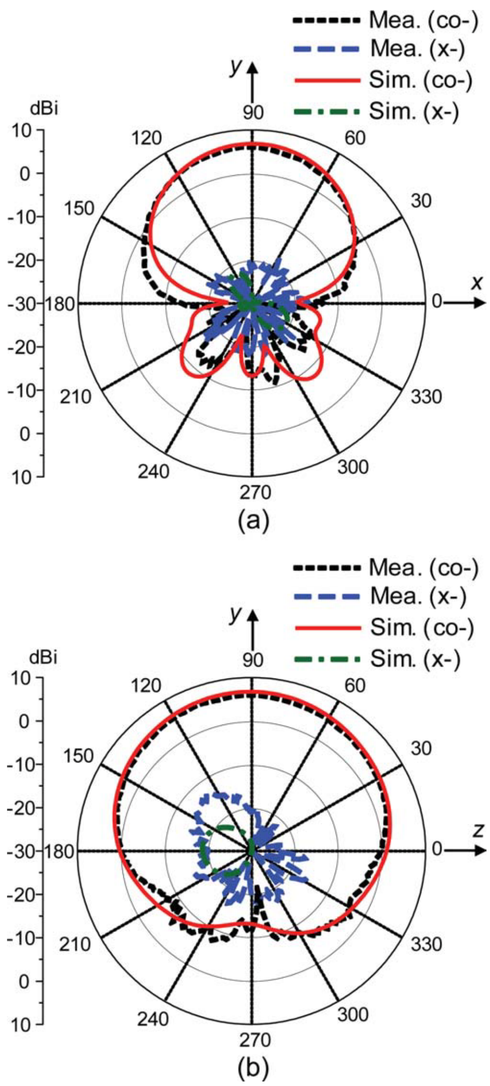

Figure 7 Radiation patterns at 7 GHz: (a) E-plane and (b) H-plane. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

3. CONCLUSIONS

This article describes a wideband quasi-Yagi antenna fed by a microstrip-to-slotline transition. The transition consists of a microstrip radial stub and slot radial stub, both at 90° but with different radii, to achieve wideband impedance matching. This antenna showed a measured bandwidth of 4.64–7.42 GHz for a −10 dB reflection coefficient, a measured gain of 6.0–6.75 dBi, and a front-to-back ratio and cross-polarization level better than 17 and −15 dB, respectively. This wideband characteristic, planar structure, minimum gain variation, and stable radiation pattern make the antenna suitable for wideband wireless communication systems, power combining, and phased arrays. It could be scaled for applications at millimeter-wave frequencies, such as automotive radar and high-data-rate communication systems.

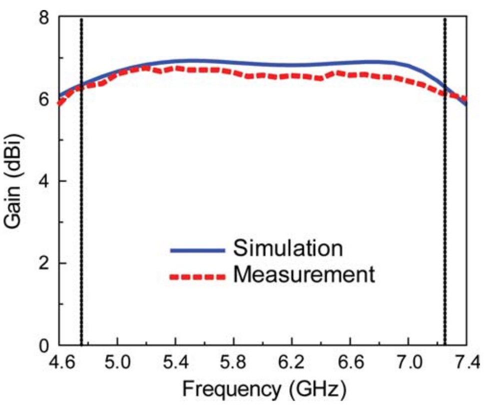

Figure 8 Gain of the antenna. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com]

REFERENCES

1. N. Kaneda, W. Deal, Y. Qian, R. Waterhouse, and T. Itoh, A broad-band planar quasi-Yagi antenna, IEEE Trans Antennas Propag 50 (2002), 1158–1160.
2. E. Avila-Navarro, A. Segarra-Martinez, J.A. Carrasco, and C. Reig, A low-cost compact uniplanar quasi-Yagi printed antenna, Microwave Opt Technol Lett 50 (2008), 731–735.
3. D. Woo, Y. Kim, W. Kim, and Y. Cho, Design of quasi-Yagi antennas using an ultra-wideband balun, Microwave Opt Technol Lett 50 (2008), 2068–2071.
4. L. Truong, Y. Baek, M. Lee, S. Park, S. Lee, and J. Rhee, A high-performance 94 GHz planar quasi-Yagi antenna on GaAs substrate, Microwave Opt Technol Lett 5 (2009), 2396–2400.
5. G. Zheng, A. Kishk, A. Glisson, and A. Yakovlev, Simplified feed for modified printed Yagi antenna, Electron Lett 40 (2004), 464–466.
6. H. Kan, R. Waterhouse, A. Abbosh, and M. Bialkowski, Simple broadband planar CPW-fed quasi-Yagi antenna, IEEE Antenna Wireless Propagt Lett 6 (2007), 18–20.
7. K. Han, Y. Park, H. Choo, and I. Park, Broadband CPS-fed Yagi-Uda antenna, Electron Lett 45 (2009), 1207–1209.
8. M. Zinieris, M. Sloan, and L. Davis, A broadband microstrip-line-to-slot-line transition, Microwave Opt Technol Lett 18 (1998), 339–342.

A WIDEBAND CIRCULARLY POLARIZED ANTENNA WITH Γ-SHAPED FEED

Guang Fu, Zhi-Ya Zhang, Shao-Li Zuo, Juan Lei, and Shu-Xi Gong
Science and Technology on Antenna and Microwave Laboratory, Xidian University, Xi'an, Shaanxi 710071, China; Corresponding author: zhiyazhang@163.com

Received 20 March 2011

ABSTRACT: *A wideband circularly polarized antenna with Γ-shaped feed is presented. The proposed antenna is formed by two shorted bowtie patch antennas and two L-shaped electric dipoles. It can achieve a measured impedance bandwidth for voltage standing wave ratio (VSWR) ≤ 1.5 of 52% and a 3-dB axial ratio bandwidth of 55%. For the entire half-power beamwidth, the axial ratio can be kept below 3 dB. A prototype has been fabricated and tested, and the experimental results validate the design procedure.* © 2011 Wiley Periodicals, Inc. Microwave Opt Technol Lett 54:153–156, 2012; View this article online at wileyonlinelibrary.com. DOI 10.1002/mop.26503

Key words: *circularly polarized antenna; Γ-shaped feed; impedance bandwidth; axial ratio bandwidth*

1. INTRODUCTION

Circular polarization (CP), compared to linear polarization, allows for greater flexibility in orientation angle between transmitter and receiver, better mobility and weather penetration, and reduction in multipath reflections and other kinds of interferences.