

## Diminutive Impedance-Matching Splitters (AN-10-004)

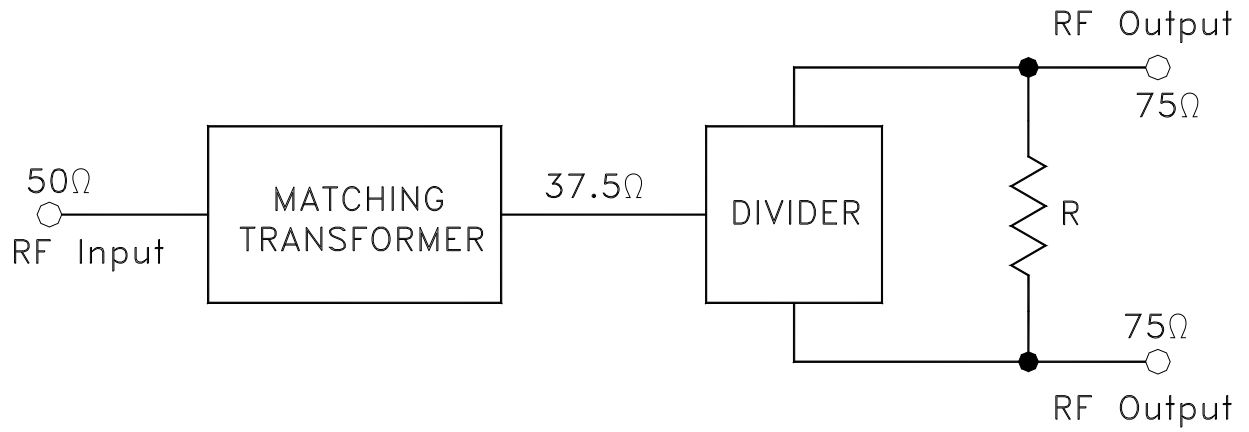
### Introduction

These tiny power splitters deliver full-sized performance transforming between 50 $\Omega$  and 75 $\Omega$ , from 5 to 1000 MHz.

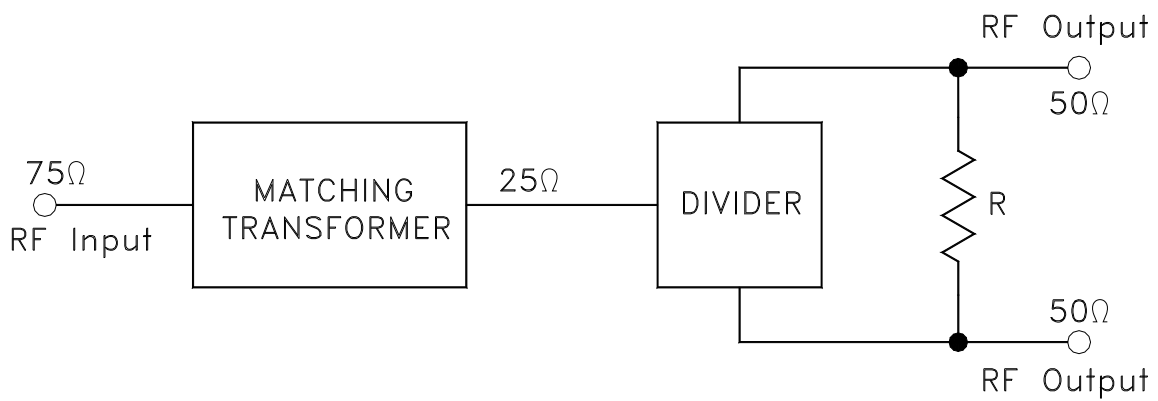
Traditionally, power dividers/combiners are invaluable passive components that allow transmitters and receivers to combine or divide signals as necessary. Component availability for characteristic impedance of 50 $\Omega$  is ample. A mixed impedance splitter (50 $\Omega$  at input and 75 $\Omega$  at output, or 75 $\Omega$  at input and 50 $\Omega$  at output) can help in certain signal processing applications, such as realization of 75 $\Omega$  balanced amplifiers.

Basically, a power splitter is formed of an input impedance-matching section, a divider section, and a resistor. Consider a system that needs to split a signal from input at 50 $\Omega$  to two outputs at 75 $\Omega$ . As shown in Fig. 1, the impedance at the input of the divider is nominally 37.5 $\Omega$ . The matching transformer converts this impedance to 50 $\Omega$  input with minimal signal power loss. Oppositely, a system to split a signal from input at 75 $\Omega$  to output at 50 $\Omega$  is shown in Fig. 2. The impedance at the input of the divider is close to 25 $\Omega$ . The matching transformer converts this low impedance to 75 $\Omega$  at the RF input.

The resistor (R) plays a critical role in providing isolation between the two RF output ports. A capacitor is incorporated within the device to optimize frequency bandwidth.



**Figure 1 – Input at 50Ω to Two Outputs at 75Ω**



**Figure 2– Input at 75Ω to Two Outputs at 50Ω**

## Construction

The base of Mini-Circuits matching splitter models SBTC-2-10-5075 and SBTC-2-10-7550 is constructed using Blue Cell™ technology, which utilizes low temperature co-fired ceramic (LTCC). This makes it possible to embed the resistor and part of the matching network within the power-splitter circuitry, while the base supports a ferrite transformer to form the divider and to complete the matching function. Connections between components are formed through the company's proprietary welding process. Please refer to application note AN-40-004 for reflow soldering guidance.

## Performance

Model SBTC-2-10-5075 is a two-way splitter from 50Ω input to 75Ω output. It shows about 1dB insertion loss up to 860 MHz and 1.2dB at 1000 MHz (above the 3dB split); see Fig. 3. Also, it has excellent VSWR (Voltage Standing Wave Ratio) as shown in Fig. 4: 1.05 – 1.20 (typ.) at the input (Port S) and 1.15 – 1.35 (typ.) at the outputs (Ports 1 and 2) from 50 to 1000 MHz. The specifications are given in Table 1.

Model SBTC-2-10-7550 is a two-way splitter from 75Ω input to 50Ω output. It has less than 1dB insertion loss from 5 to 1000 MHz as Fig. 5 shows. VSWR is 1.25.(typ.) up to 600MHz at both input and output. It rises at higher frequencies; peaking at 1.40 (typ.) at the input. See Fig. 6. The specifications are in Table 2.

Both of these devices can handle input power level up to 0.5W when used as a splitter, and 0.125W when used as a power combiner.

### Electrical Specifications

FREQ. RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB) ABOVE 3.0 dB			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)								
	L	M	U	L	M	U	L	M	U	L	M	U						
$f_L$ - $f_U$	Typ. Min.	Typ. Min.	Typ. Min.	Typ. Max.	Typ. Max.	Typ. Max.	Max.	Max.	Max.	Max.	Max.	Max.						
50-1000	25	16	—	—	20	15	0.7	1.2	—	—	1.0	1.6	3	—	5	0.6	—	0.5

L = low range [ $f_L$  to 10  $f_L$ ]      M = mid range [10  $f_L$  to  $f_U/2$ ]      U = upper range [ $f_U/2$  to  $f_U$ ]

**Table 1 – Model SBTC-2-10-5075, 50Ω Input to 75Ω Output**

### Electrical Specifications

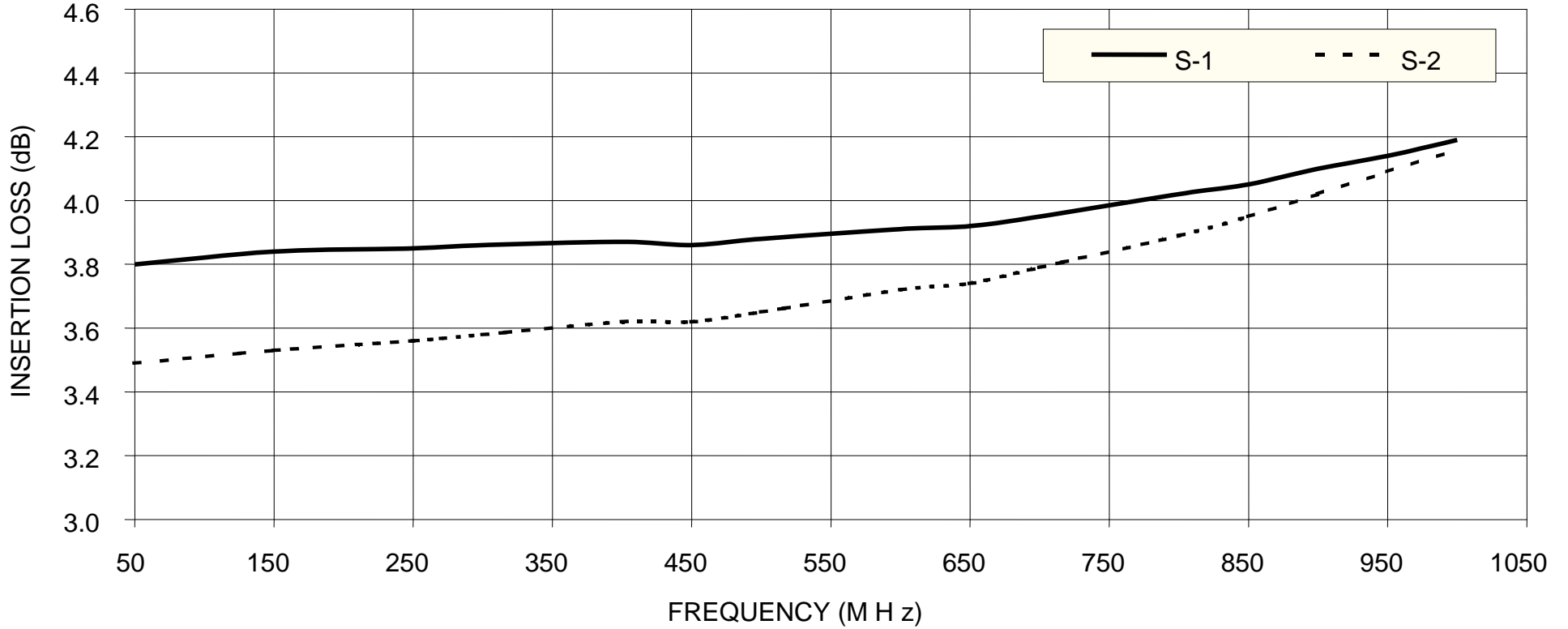
FREQ. RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB) ABOVE 3.0 dB			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)								
	L	M	U	L	M	U	L	M	U	L	M	U						
$f_L$ - $f_U$	Typ. Min.	Typ. Min.	Typ. Min.	Typ. Max.	Typ. Max.	Typ. Max.	Max.	Max.	Max.	Max.	Max.	Max.						
5-1000	23	13	24	20	26	20	0.5	1.3	0.6	1.1	0.7	1.5	6	3	5	0.8	0.5	0.5

L = low range [ $f_L$  to 10  $f_L$ ]      M = mid range [10  $f_L$  to  $f_U/2$ ]      U = upper range [ $f_U/2$  to  $f_U$ ]

**Table 2 – Model SBTC-2-10-7550, 75Ω Input to 50Ω Output**

# SBTC-2-10-5075 INSERTION LOSS

at RF level -10 dBm



**Figure 3**

SBTC-2-10-5075  
VSWR

at RF level -10 dBm

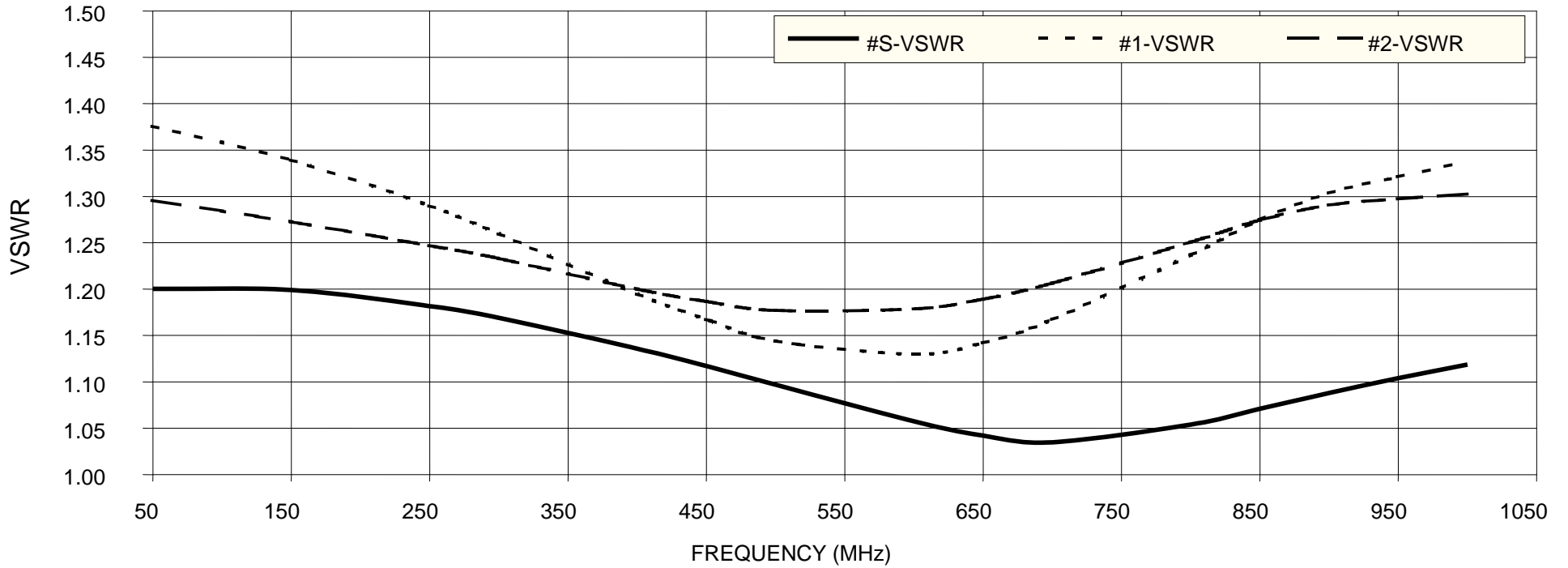


Figure 4

SBTC-2-10-7550  
INSERTION LOSS

at RF level -10 (dBm)

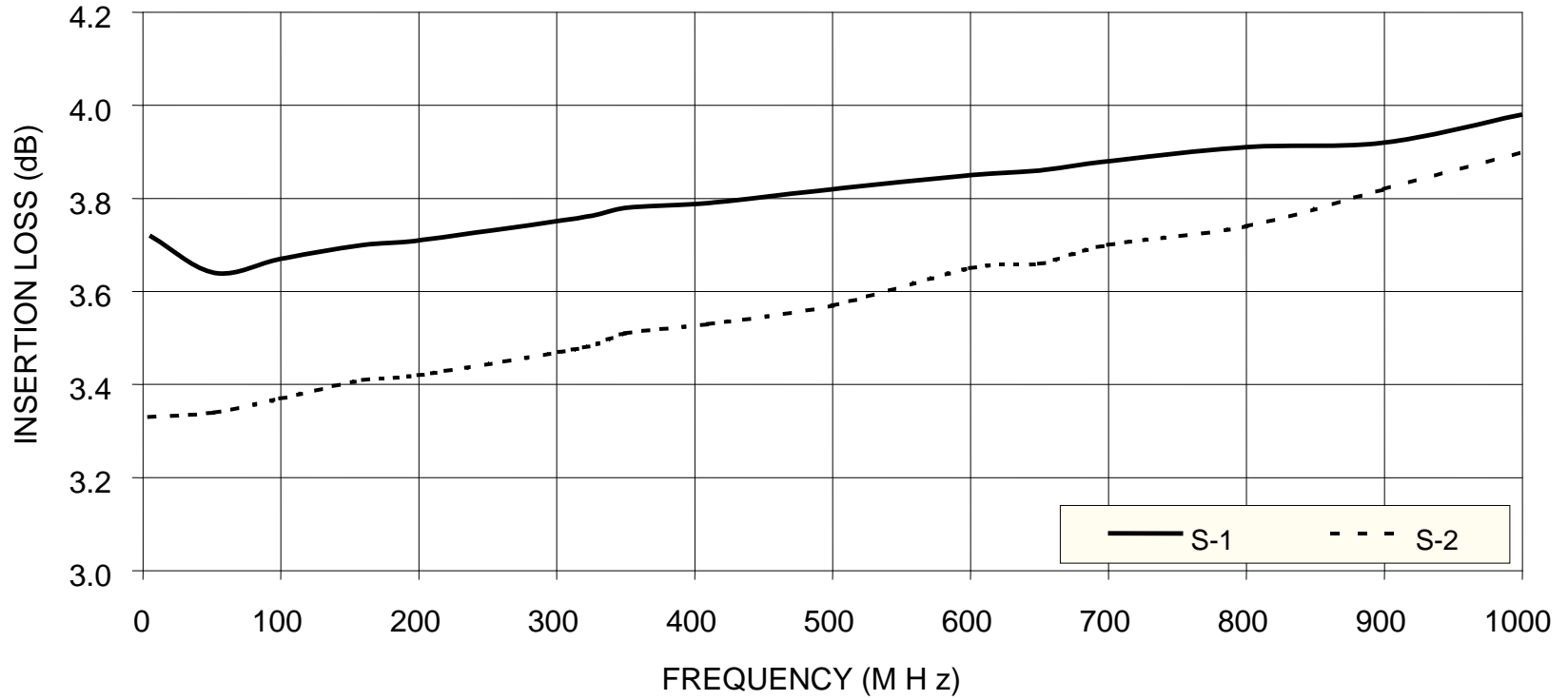
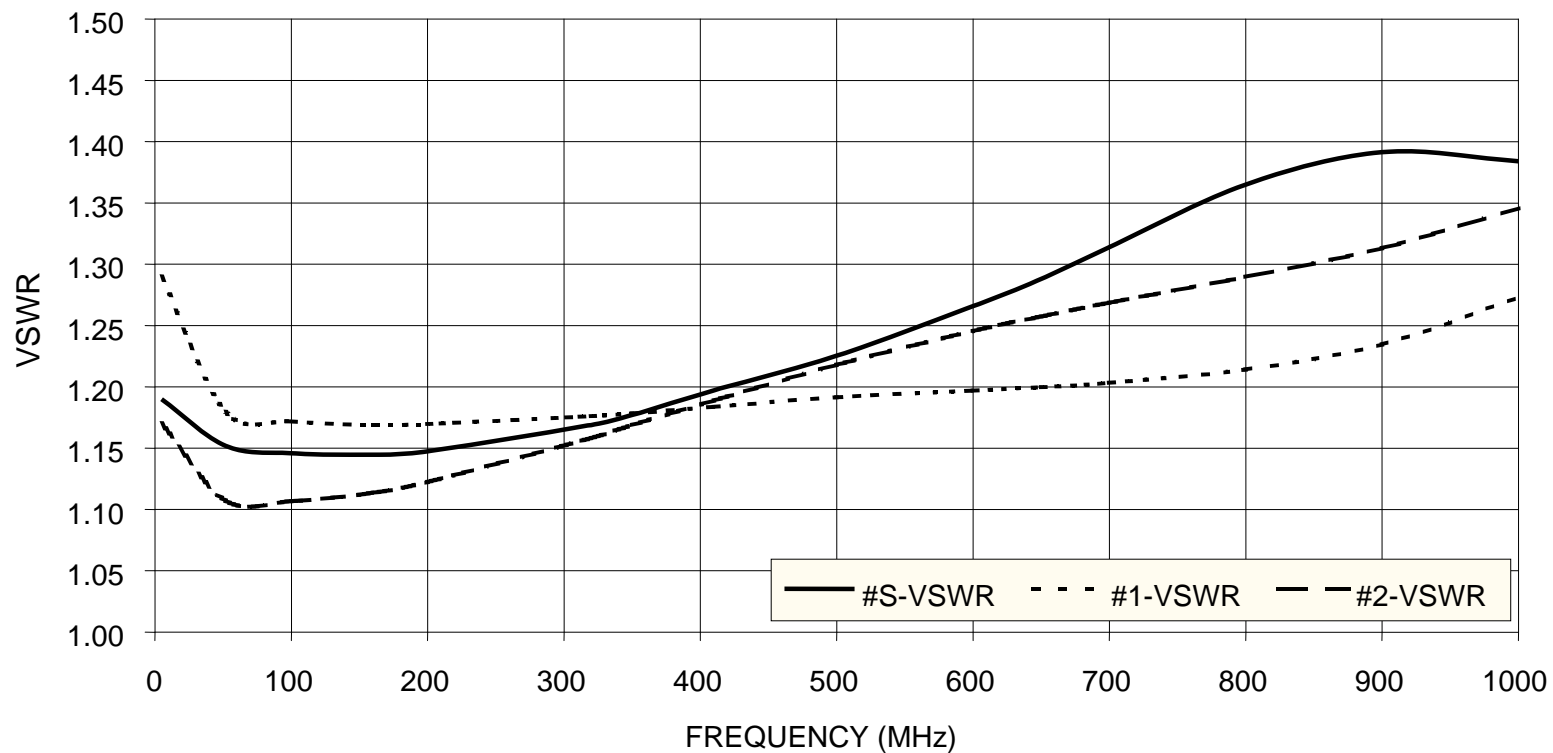


Figure 5

# SBTC-2-10-7550

## VSWR

at RF level -10 (dBm)

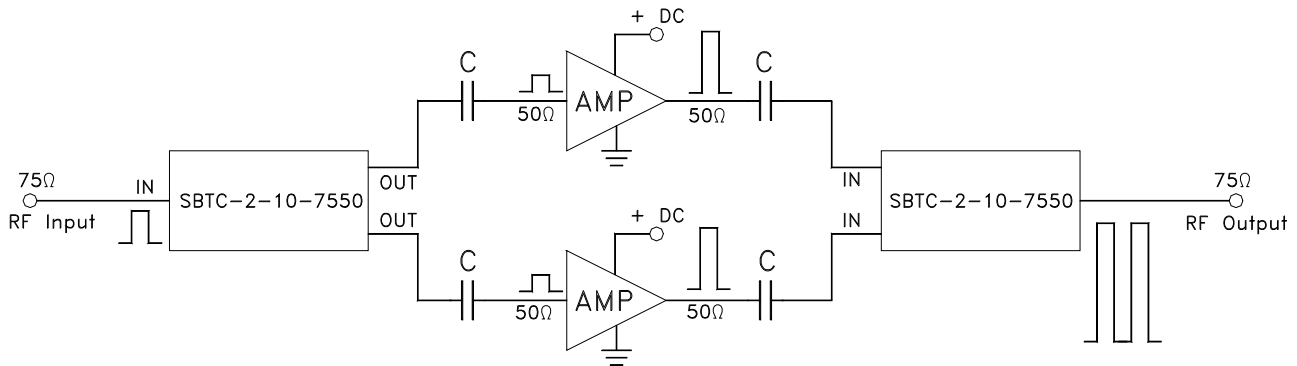


**Figure 6**

## What are the applications for these products?

### Example 1:

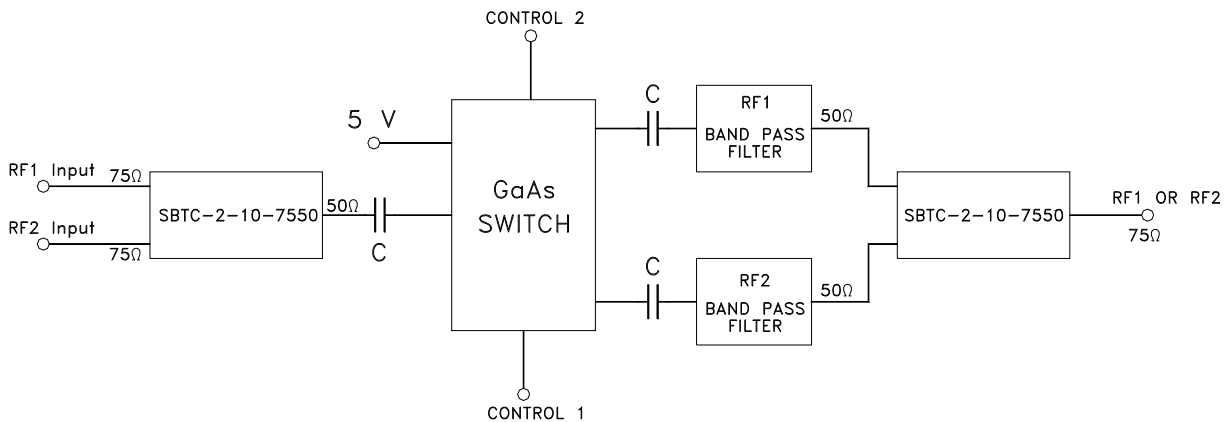
Usually, a cable system operates at 75Ω impedance. But, most of RF amplifiers have 50Ω impedance. By using the circuit shown below, Fig. 7, amplification of RF signals in a 75Ω system is possible with 50Ω amplifiers. With impedances matched in the circuit, maximum power will be transferred and the system designer has more choice of amplifiers.



**Figure 7 – Balanced 50Ω Amplifier in a 75Ω System**

### Example 2:

Many RF communication systems are using cable network now, and therefore require wide-band 75Ω RF switches. RF communication systems have traditionally been implemented in 50Ω impedance; to match, switches are generally designed for 50Ω. A pair of power splitters with 50Ω input and 75Ω output will enable a 50Ω switch to be used in a 75Ω cable network. Fig. 8 shows a circuit for selection of cable signals that can be used for network connection.



**Figure 8 – Selecting 75Ω Signals with a 50Ω Switch**



## Conclusion

These newly developed products have diminutive size, small power loss and wide bandwidth. They combine two functions in one device – power splitting/combining and impedance matching, and have many practical applications.

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