

DrawCom Pty Ltd

Catalogue Issue 9







APPLICATION NOTES & DATA

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Rectangular Waveguide Flanges Application Notes

Non pressurised Contact Flanges

Waveguide Type	Flange Series Equivalents		Style	Dimensions Inches (Millimeters)
	EIA	IEC		
WR90	CMR90	UER100		1.77 x 1.27 (45.0 x 32.3)
WR112	CMR112	UER84		2.02 x 1.38 (51.3 x 35.1)
WR137	CMR137	UER70		2.28 x 1.53 (57.9 x 38.9)
WR159	CMR159	UER58		2.50 x 1.75 (63.5 x 44.5)
WR187	CMR187	UER48		2.78 x 1.78 (70.6 x 45.2)
WR229	CMR229	UER40		3.16 x 2.00 (80.3 x 50.8)

Flange Availability

Waveguide Size

Flange Type	WR28	WR42	WR51	WR62	WR75	WR90	WR112	WR137	WR159	WR187	WR229
Choke	•	•		•	•	•	•	•		•	
Cover	•	•		•	•	•	•	•		•	
CPRG					•	•	•	•	•	•	•
CPRF						•	•	•	•	•	•
CMR						•	•	•	•	•	•
CMR Through								•			
CMR Tapped								•			
PDR		•	•	•	•	•	•	•	•	•	•
PBR	•	•		•	•	•	•				
UDR				•	•	•	•				
UBR	•	•	•	•	•	•	•				
PAR								•		•	
CBR	Please contact DrawCom Sales department										
BRJ	Please contact DrawCom Sales department										
UER								•			
UAR	Please contact DrawCom Sales department										
Cover/Gasket	•	•		•	•	•	•	•		•	

Choke, Cover and Cover/Gasket Flanges

The following flanges are square or round, depending on waveguide size. Flanges are pressurisable when used with appropriate gasket kits.

Choke, Cover and Cover/Gasket Flanges									
Waveguide	Choke Flanges			Cover Flanges			Cover/Gasket Flanges		Flange Dimensions
Type, EIA	U.S. MIL	IEC	Style	U.S. MIL	IEC	Style	IEC	Style	Inches (Millimeters)
WR42	UG-596A/U	CAR220		UG-595/U	UBR220		PBR220		0.88 (22.4) sq.
WR62	UG-541A/U	CBR140		UG-419/U	UBR140		PBR140		1.31 (33.3) sq.
WR75	51752*	CBR120		51745	UBR120		PBR120		1.50 (38.1) sq.
WR90	UG-40B/U	CBR100		UB-39/U	UBR100		PBR100		1.63 (41.4) sq.
WR112	UG-52B/U	CBR84		UG-51/U	UBR84		PBR84		1.88 (47.8) sq.
WR137	UG-343B/U	CAR70		UG-344/U	UAR70		PAR70		3.13 (79.5) dia.
WR159	–	CAR58		–	UAR58		PAR58		3.38 (85.9) dia.
WR187	UG-148C/U	CAR48		UG-149A/U	UAR48		PAR48		3.63 (92.2) dia.
WR284	UG-54B/U	CAR32		UG-53/U	UAR32		PAR32		5.31 (134.9) dia.

**Bolt hole positions are rotated 22.5° from the positions shown.




















Choke Flanges - CBR, CAR and Equivalent UG Series include a gasket groove, choke, and tapped holes for mating with cover flanges. Two choke flanges cannot be mated.

Cover Flanges - UBR, UAR and Equivalent UG Series are flat, without a gasket groove, and have clear holes for mating with choke flanges and other cover flanges. Use of a special seal is required for pressurization of two mating cover flanges.

Cover/Gasket Flanges - PBR and PAR Series are flat, include a gasket groove, and have clear holes for mating with cover, choke, or other cover/gasket flanges. Cover/gasket flanges use a single gasket when mated with cover flanges and a double gasket when mated with choke flanges or other cover/gasket flanges.

Pressurisable Contact Flanges

Contact flanges are rectangular and have clear holes secured with bolts and nuts. The flanges are pressurisable when used with the appropriate gaskets.

Pressurisable Contact Flanges								
Waveguide Type, EIA	EIA	With Groove MIL Type	IEC	Style	EIA	Without Groove MIL Type	Style	Dimensions Inches (Millimeters)
WR75	–	–	PDR120		–	–	–	1.94 x 1.57 (49.2 x 39.9)
WR90	CPR90G	UG-1360/U	PDR100*		CPR90F	UG-1736/U		2.09 x 1.59 (53.1 x 40.4)
WR112	CPR112G	UG-1358/U	PDR84*		CPR112F	UG-1734/U		2.50 x 1.75 (63.5 x 44.5)
WR137	CPR137G	UG-1356/U	PDR70**		CPR137F	UG-1732/U		2.69 x 1.94 (68.3 x 49.3)
WR159	CPR159G	UG-1354/U	PDR58		CPR159F	UG-1730/U		3.19 x 2.44 (81.0 x 62.0)
WR187	CPR187G	UG-1352/U	PDR48		CPR187F	UG-1728/U		3.50 x 2.50 (88.9 x 63.5)
WR229	CPR229G	UG-1350/U	PDR40		CPR229F	UG-1726/U		3.88 x 2.75 (98.6 x 69.9)
WR284	CPR284G	UG-1348/U	PDR32		CPR284F	UG-1724/U		4.50 x 3.00 (114 x 76.2)
WR340	CPR340G	UG-1346/U	PDR26		CPR340F	UG-1712/U		5.44 x 3.75 (138 x 95.3)
WR430	CPR430G	UG-1344/U	PDR22		CPR430F	UG-1716/U		6.34 x 4.19 (161 x 106)

*Mates with equivalent CPR series flange with metric hardware only. **Mates with equivalent CPR series flange with imperial hardware only.

CPRG Series include a gasket groove and mate with another CPRG using the supplied full thickness gasket and imperial hardware.

PDR Series include a gasket groove and mate with another PDR using the supplied two gaskets and metric hardware. Compared with CPRG, PDR flanges have deeper gasket grooves and use different gaskets.

CPRF Series do not include a gasket groove and, when mated with another CPRF, require a special seal. CPRF mates with CPRG using a CPR half gasket.

To Mate CPRG with PDR use one CPR half thickness gasket and the gasket supplied with the PDR flange. Except where noted otherwise in the table, either imperial (CPR) or metric (PDR) hardware can be used. Small tolerance differences between imperial and metric hardware to mate CPR/PDR flanges result in negligible VSWR contributions.

Mating Information



Choke/Cover Flanges (Square or Round)					
	Choke UG	Choke CBR	Cover UG	Cover UBR,UAR	Cover/Gasket PBR, PAR
Choke UG	Does NOT Mate	Does NOT Mate	Mates	Mates	Mates
Choke CBR, CAR	Does NOT Mate	Does NOT Mate	Mates	Mates	Mates
Cover UG	Mates	Mates (NOT pressurizable)	Mates (NOT pressurizable)	Mates	Mates
Modified UG Cover w/ Gasket Groove	Mates	Mates	Mates	Mates	Mates
Cover UBR, UAR	Mates	Mates (NOT pressurizable)	Mates (NOT pressurizable)	Mates	Mates
Cover/Gasket PBR, PAR,	Mates	Mates	Mates	Mates	Mates

Contact Flanges (Rectangular)			
	CPRG	CPRF	PDR
CPR90G	Mates using Full Height Gasket Kit	Mates using Half Height Gasket Kit	Mates using Half Height Gasket Kit and metric hardware
CPR112G	Mates using Full Height Gasket Kit	Mates using Half Height Gasket Kit	Mates using Half Height Gasket Kit and metric hardware
CPR137G	Mates using Full Height Gasket Kit	Mates using Half Height Gasket Kit	Mates using Half Height Gasket Kit and imperial hardware
CPR159G	Mates using Full Height Gasket Kit	Mates using Half Height Gasket Kit	Mates using Half Height Gasket Kit and metric or imperial hardware
CPR187G	Mates using Full Height Gasket Kit	Mates using Half Height Gasket Kit	Mates using Half Height Gasket Kit and metric or imperial hardware
CPR229G	Mates using Full Height Gasket Kit	Mates using Half Height Gasket Kit	Mates using Half Height Gasket Kit and metric or imperial hardware
CPR284G	Mates using Full Height Gasket Kit	Mates using Half Height Gasket Kit	Mates using Half Height Gasket Kit and metric or imperial hardware
CPR90F	Mates using Half Height Gasket Kit	Mates (NOT Pressurisable)	Mates using metric hardware
CPR112F	Mates using Half Height Gasket Kit	Mates (NOT Pressurisable)	Mates using metric hardware
CPR137F	Mates using Half Height Gasket Kit	Mates (NOT Pressurisable)	Mates using imperial hardware
CPR159F	Mates using Half Height Gasket Kit	Mates (NOT Pressurisable)	Mates using metric or imperial hardware
CPR187F	Mates using Half Height Gasket Kit	Mates (NOT Pressurisable)	Mates using metric or imperial hardware
CPR229F	Mates using Half Height Gasket Kit	Mates (NOT Pressurisable)	Mates using metric or imperial hardware
CPR284F	Mates using Half Height Gasket Kit	Mates (NOT Pressurisable)	Mates using metric or imperial hardware
PDR180	Does NOT Mate	Does NOT Mate	Mates
PDR140	Does NOT Mate	Does NOT Mate	Mates
PDR120	Does NOT Mate	Does NOT Mate	Mates
PDR100	Mates using Half Height Gasket Kit and metric hardware	Mates using metric hardware	Mates
PDR84	Mates using Half Height Gasket Kit and metric hardware	Mates using metric hardware	Mates
PDR70	Mates using Half Height Gasket Kit and imperial hardware	Mates using imperial hardware	Mates
PDR48	Mates using Half Height Gasket Kit and metric or imperial hardware	Mates using metric or imperial hardware	Mates
PDR40	Mates using Half Height Gasket Kit and metric or imperial hardware	Mates using metric or imperial hardware	Mates
CMR	Mates with CMR and UER "ONLY"		
UER	Mates with CMR and UER "ONLY"		

Power Dividers as Combiners

The limiting factor for most Wilkinson power dividers used as combiners is power dissipation. When input signals are out of phase, non-coherent or have amplitude unbalance this causes a cancellation across the isolation resistors resulting in power dissipation.

Since these devices are most commonly used as dividers, typical industry designs utilize low power alumina surface mount resistor chips on a thermally insulative circuit board. However, maximum input for combining non-coherent signals on adjacent ports is: $(\text{rated input power of divider} * 5\%) / "N" \# \text{ of input channels}$. If the rated power is exceeded, the chip resistors will heat up and degrade resulting in loss of port-to-port isolation and VSWR.

DrawCom's 50 Watt M-Series Power Divider/Combiners overcome these limits by employing higher power resistors mounted on a high thermal conductivity substrate having three times the heat transfer capability of ordinary circuit board materials which increases max input for combining non-coherent signals on adjacent ports. Eight models are available covering the frequency range from **0.800 - 2.200 GHz**. Choose from **2-way, 3-way, 4-way, 8-way and 16-way** configurations in N-Female and SMA-Female connector styles.

For higher power combining applications, check out the 80 & 100 watt H-Series Combiners & Dividers.

Source: www.e-meca.com

Reactive RF Splitters

Introduction

Reactive splitters have long been the prevailing signal distribution component for antenna arrays and radiating cable systems for in-building deployments because of their low loss and rugged nature. Unlike Wilkinson power dividers that use internal resistors to provide isolation between the output paths, reactive splitters are quarter wave length lines matched to split signals evenly to the output paths. This characteristic allows for efficient, high power, broadband operation with minimal solder joints and low passive intermodulation (PIM) characteristics.



RF Splitter

Why reactive splitters are not suitable for combining

Reactive splitters, by design, do not provide isolation between the output ports and exhibit very poor VSWR looking back into the device, so they should not be used as combiners. Applications that employ a need for both combining and dividing benefit greatly by use of a Wilkinson power divider/combiner, but special care must be taken to not damage the input resistor.

Most industry Wilkinson power dividers are rated between 10–30 watts but can only handle a few mW as an unbalanced combiner. As a general rule to calculate combining rated power, the following formula is used: (rated input power of divider * 5%) / "N" # of input channels = max input at each port for combining

For higher power Wilkinson combining applications, check out DrawCom's H-Series Combiners.

Ordering

DrawCom introduces a new line of compact, high-power capable (200 watts) reactive splitters covering all wireless frequencies from 0.800 - 2.700 GHz. Available in 2-way and 3-way configurations fitted with **7-16, N** or **SMA-Female** connectors at all ports. Indoor or Outdoor use (IP65).

This RF power splitter series provides a low loss, equal power split at all output ports while maintaining excellent amplitude and phase balance. **Our unique design eliminates the need for extraneous (often misplaced) mounting hardware.**

Source: www.e-meca.com

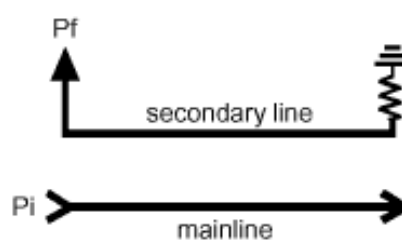
Directional Coupler Basics

Over the years many different techniques have been utilized to bring about the physical realization of directional couplers. The scope of this article is limited to discussion of quarter-wavelength, coaxial, directional couplers, as this type of coupler represents a balanced compromise between functional range, performance and cost for most broadband applications covering up to an octave bandwidth.

The basic directional coupler is a four port junction that is used in a wide variety of microwave systems to satisfy almost any requirement for sampling incident and reflected microwave power conveniently and accurately with minimal disturbance to the transmission line.

The basic configuration of a single directional coupler is shown in **figure 1** which illustrates two parallel transmission lines over a length of one-quarter wavelength, corresponding with the center frequency of operation. The main and secondary lines are separated by a calculated physical distance which determines the coupling factor of the device. The physically closer the lines are to each other, the more power will be introduced on the secondary line. The term **coupling** denotes how much of the input power is sampled to the coupled port and is defined as 10 times ratio of Incident Power and Forward Power $C = 10 \log_{10}(P_f/P_i)$.

Typical coupling values found in practice are 3, 6, 10, 20, 30, 40 & 50 dB; however, practically any coupling value may be obtained through proper design.

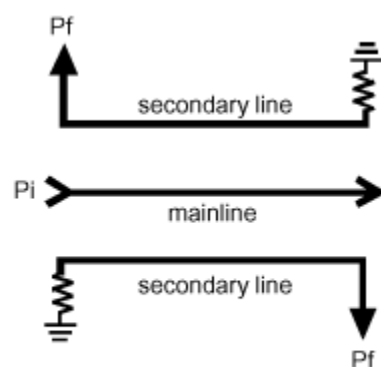


P_i = Incident Power
 P_f = Forward Power

Single Directional Coupler
 Fig. 1

Directional Coupler Theory and Definitions

A dual directional coupler (**figure 2**) is essentially two single directional couplers connected back-to-back sharing a common mainline and providing two output ports with high isolation between those ports. This high isolation is critical for the accuracy of reflectometer set-ups that simultaneously sample input power to a device or load providing a ratio of signals for the purpose of determining return loss in decibels.

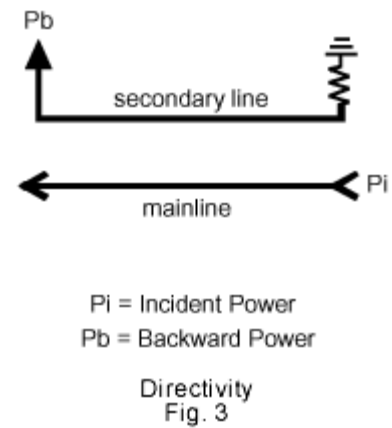


Dual Directional Coupler
 Fig. 2

Source: www.e-meca.com

Directional Coupler Basics (cont.)

When power is introduced at the input port, all of the power appears at the output port except for the portion intended to be sampled. If power is reflected back from the output port, the ideal directional coupler does not allow any of the reflected power to appear on the secondary line. Regrettably, the ideal directional coupler does not exist in our world. Consequently, a small amount of backward power will be coupled to the secondary line 180° out of phase from the incident wave cancelling power on the secondary line and adding uncertainty to the measurement. The term **directivity** (**figure 3**) denotes the ratio of forward to backward coupling and is defined as 10 times the common log of the ratio of forward and backward power $D = 10 \log_{10}(P_f/P_b)$. The higher the value of directivity, the less backward power is sampled and measurement uncertainty is significantly improved. Directivity is the qualitative benchmark by which couplers are compared.



Since we are on the subject of measurement errors, we should also deal with the importance of Voltage Standing Wave Ratio (VSWR) because reflections will add and subtract to the incident signal causing uncertainty in the coupling factor. VSWR is defined as the ratio of incident to reflected signals and is ideally 1.00:1, meaning these signals are in phase and will not cancel. The better the **VSWR**, the less return loss is encountered. Unsatisfactory coupler VSWR will degrade measurement accuracy and is usually attributable to lesser quality connectors or inadequate design techniques.

The **frequency sensitivity** or “flatness” of a coupler is a measure of how coupling varies over a given frequency range. Optimum coupling frequency response is achieved by “centering” the design within the specified band of interest. Typical coupling flatness for a quarter-wavelength coupler operating over an octave band is within ± 0.75 dB of nominal. All things being equal, stronger coupling factors (3, 6 & 10 dB) exhibit greater flatness than weaker coupling factors (20 through 50 dB). When operating over frequency bands greater than an octave, the flatness tolerance may need to be relaxed due to the inherent characteristics of coupling roll-off.

Another important consideration when specifying a coupler is to ensure the device has minimal mainline insertion loss. Through virtue of their design, coaxial air-line couplers offer the lowest possible loss when inserted in a transmission path. Generally, the **insertion loss** of a coupler (or any microwave device for that matter) becomes more significant at higher frequency, namely because loss increases with frequency and higher frequency power sources are considerably more expensive. Accordingly, the criteria of low insertion loss will prevent precious power from being wasted on measurement components.

Directional Coupler Basics (cont.)

When specifying a directional coupler with a coupling factor stronger than 20 dB (3, 6 or 10 dB), consideration should also be given to the theoretical insertion loss caused by power coupling from the mainline. **Table 1** illustrates the amount of additional loss the device exhibits as a function of the proximity of the two transmission lines. It should also be noted that dual directional couplers exhibit twice the loss of single directional models because there are two secondary lines drawing power from the mainline.

Table 1

Theoretical Mainline Insertion Loss Due to Coupling Factor (dB)							
Coupling Factor	3 dB	6 dB	10 dB	20 dB	30 dB	40 dB	50 dB
Single Directional Coupler	3.01	1.2560	0.4560	0.0436	0.0043	0.0004	0.00004
Dual Directional Coupler	6.02	2.5120	0.9120	0.0872	0.0086	0.0008	0.00008

Directional Coupler Solutions from DRAWCOM

We supply both coaxial air-line and stripline couplers. Through virtue of their design, air-line couplers are high power capable and offer the lowest possible insertion loss. The unique matching techniques used in their construction also provide exceptionally high directivity and the best possible VSWR. Stripline couplers offer the advantage of multi-octave frequency coverage in miniature package sizes for improved packaging density.

We supply a wide selection of directional couplers optimized to the microwave engineer's critical specifications. Standard coupling values of 3, 6, 10, 20, 30, 40 and 50 dB are available for just-in-time requirements. Custom options include dual and tri-couplers, special coupling values, frequency ranges to 18 GHz, external high power terminations and alternate connector styles or plating. All models may be specified without an internal termination for bi-directional coupling, and passive intermodulation (PIM) compliant models are available when silver-plated connectors are specified.

Source: www.e-meca.com

Isolator & Circulator Basics

An RF isolator is a two-port passive device made of magnets and ferrite material which is used to protect other RF components from excessive signal reflection, while an RF circulator is a three-port passive device used to control the direction of signal flow in a circuit.

To understand how these components control the signal flow, think of a cup of water into which you place a spoon and stir in a clockwise motion. If you sprinkle some pepper into the cup and continue to stir, you will notice that the pepper easily follows the circular motion of the water. You can also see that it would be impossible for the pepper to move in a counterclockwise direction because the water motion is just too strong. The interaction of the magnetic field to the ferrite material inside isolators and circulators create magnetic fields similar to the water flow in the cup. The rotary field is very strong and will cause any RF/microwave signal placed at one port to follow the magnetic flow to the adjacent port and not in the opposite direction.

Figure 1 shows the schematics for a circulator and an isolator. Notice how an isolator is a circulator with the third port terminated. The arrows represent the direction of the magnetic fields and the signal when applied to any port of these devices. Example: If a signal is placed at port A, and port B is well matched, the signal will exit at port B with very little loss (typically 0.4dB). If there is a mismatch at port B, the reflected signal from port B will be directed to port C.



Isolation

An important consideration when specifying an isolator or circulator is to ensure the device has adequate isolation between the ports for your given application. The amount of isolation is directly affected by the load at port 3.

If the match on port 3 is poor, you can expect isolation below 10 dB, but if the match is improved to 1:10:1 by using a good termination device in the circuit, then the isolation would improve to over 20 dB.

Source: www.e-meca.com

Isolator & Circulator Basics (cont.)

Common Applications

A common application for a circulator is as a duplexer (a transmitter and receiver sharing one antenna). **Figure 2** shows that when the transmitter at port A sends out a signal, the output goes directly to the antenna at port B and does not leak back into the receiver at port C due to the isolation of the circulator. Good isolation is key to ensure that a high-power transmitter output signal does not get back the receiver front end. In this configuration, all signals from the antenna go straight to the receiver and not the transmitter because of the circular signal flow (remember the cup of water).

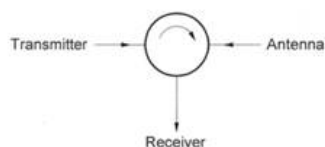


FIGURE 2 - Duplexor

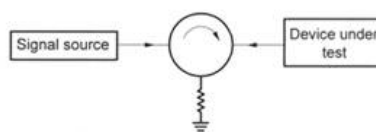


FIGURE 3

Figure 3 shows a common test bench application where an isolator is placed in a measurement path so that any variations in the device under test (DUT) will end up at the termination of the isolator and not back to the signal source.

Power Ratings

DrawCom isolators are designed with an internal 10w load capability. However, the recommended maximum power that our devices can sustain is 2w to allow for de-rating and heat transfer. Higher isolator power levels can be achieved utilizing our circulators with an external load. DrawCom offers an extensive selection of high power, low loss RF loads. Please consult with DrawCom to discuss your requirement.

Special Handling & Storage

Isolators and circulators have magnets that produce strong fields to control signal flow. As is the case with any magnet, when placed in close proximity to another these fields oppose one another and over time, will weaken the strength of the magnets. This is called degaussing. A similar effect can be seen when stored in close proximity to ferrous metals. Special care should be taken when storing any isolators/circulators and MECA recommends that the devices should be separated by 3 inches from each other & all ferrous surfaces to reduce degaussing effects.

Ordering

DrawCom offers a broad range of isolators and circulators in both N, SMA and waveguide. The most “popular” frequency bands between 0.8 - 8.0 GHz are readily available and can ship from STOCK to 2 weeks after receipt of your order.

Source: www.e-meca.com

RF Over Fibre



DrawCom represents Axell Wireless who are experienced in providing fibre optic fed coverage enhancement systems. Their wide experience in supplying cell enhancer equipments has been the basis of the systems solutions using fibre optics. Conventional cell enhancers are fed via an off-air antenna, or via coaxial cable, to repeat the wanted signals into an area without radio coverage. The use of fibre optics allows the off-air or BTS to be extended over great distances to remote locations.

Typically, cell enhancers are used locally at the area to be improved e.g. in-building, at the entrance of a tunnel or over a hill. The main limitation can be lack of sufficient isolation between the donor and in-fill antenna to prevent oscillation. Fibre fed systems separate the donor or master site from the in-fill site by the use of fibre optic cables, which provides higher isolation and allows the signals to be fed over greater distances without excessive cable attenuation.

The fibre optic systems are particularly suited to tunnel applications. Conventional daisy chained amplifiers fed via coax are limited by cable attenuation and amplifier intermodulation noise. Repeater reliability is a big issue also as failure of one amplifier can render the remainder of the cascaded chain useless. With fibre fed systems, each remote tunnel amplifier is fed radially with individual fibre cables from the master site. This provides a more robust solution against failure.

Fibre fed systems permit wide area low capacity coverage solutions at reduced costs. A base station may have a number of carriers and capacity to handle many calls. The use of multiple base stations, one for each location is expensive in terms of capital equipment and the ongoing line leasing costs for the control and modulation. With fibre fed systems a single BTS or off-air site is nominated as the master and each remote location is fed from that service. Hence BTS infrastructure costs are kept to a minimum, the use of off-air from existing coverage areas reduces the costs even further. Low capacity, low use users such as emergency services can benefit from the low cost implementation of coverage into tunnels.

System Design Issues:

There are a number of issues which need to be determined before designing a fibre fed system, including: frequency, power input/output, gain, number of sites etc. The wide bandwidth of the fibre optic equipment enables frequencies from 70 to 2500MHz to be sent via the fibre cable. The required frequencies are broken down into their specific operating bands and the frequencies from various services in the wide range can be coupled into the fibre by using cross band couplers.

The fibre optic transmitter is normally limited to a low level of composite power, thus any drive signals taken from a local BTS must be limited to prevent overload and intermodulation products being passed to the remote site. In the uplink direction, dynamic range and gain is important to prevent overload or near/far effect drop out when providing coverage to a number of subscribers in a cellular band, for example.

The propagation system will determine the amount of near/far effect dynamic range; leaky cable systems are more tolerant than antenna systems. The consistent coupling factor and low longitudinal attenuation give less than 40dB of level change.

Fibre Optic Solutions



General overview of RF over Fibre

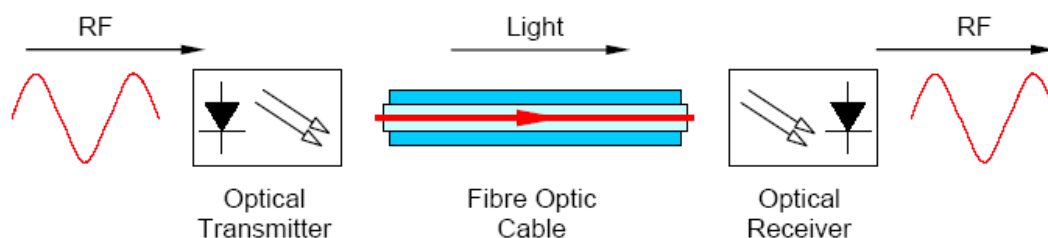
RF over Fibre techniques allow a large number of radio channels in different bands to be transported long distances over fibre optic cable with minimal degradation of the original RF signals. Multi-band combining techniques are applied prior to the RF / Fibre conversion and multi-band filtering and amplifier techniques are used to reconvert the optical signals to RF.

RF over Fibre is a solution particularly well adapted to the multi and mono band coverage requirements of metro railway systems and other indoor applications.

The key components of an RF over Fibre solution can be quantified as follows:

Monomode Fibre Optic Cable

The fibre has a very fine fibre inner core. The optical signal transmitted in the fibre is relatively unaffected by reflection and refraction, allowing the signal to travel long distances along the fibre without compromising the quality of the signal received at the far end.



It should be noted that the alternative fibre to Monomode, is Multimode fibre. This type of fibre is not particularly well adapted to RF applications over long distances as the optical signal passing through the fibre is subject to degradation from the refraction and reflections occurring within the fibre. The higher attenuation of the Multimode fibre means that Multimode fibre is used over relatively short distances.

FO Transmitters

The Fibre Optic transmitters and receivers must operate on a common optical wavelength. Presently, 2 wavelengths are adapted to Monomode applications, 1310 nm and 1550 nm. In general, the transmitter RF input port can only accept a maximum peak envelope power (PEP) of 0 dBm. Therefore, for multi channel or multi band applications it is necessary to verify the PEP of the RF input to the FO transmitter. An alarm circuit monitors the bias current of the laser and indicates an alarm if too much or too little current is being drawn.

FO Receivers

The optical receiver feeds a low noise amplifier. The intermodulation performance of this amplifier determines the output signal level per carrier. An alarm facility is available to indicate low optical input. For general applications, the RF carrier levels will typically be in the range -20 to -10dBm.

Fibre Optic Solutions (cont.)

Fibre Optic Connectors

Particular care has to be taken when handling FO connectors. Unnecessary handling of the connectors is best avoided as dust on the fibre or a poor mating connection can severely attenuate the optical signal. At each installation, verify the connector type prior to connection. The external housing of certain connectors is identical to that of our preferred connector, the FC/APC, which means that this type of connector can be joined to another type, resulting in high attenuation of the optical signal. The FC/APC offers a large surface area of contact between both fibres.

Optical Couplers and Splitters

As with RF applications, the optical signal can be split equally into several different fibres or the signal can be coupled off a fibre with a fixed level of coupling loss. Care should be taken in selecting the coupler or splitter to be used as they are wavelength dependent, and therefore need to be compatible with the RF/Fibre converters. For either solution, it is recommended that the overall link budget should not exceed 9 dB_{optic} (or 18 dB_{RF}). It should be noted that 1dB_{optic} = 2 dB_{RF}.

System Solutions

As detailed previously, optical signals can be split into several outputs or coupled from the fibre to the receiver. These solutions apply principally to the DL component of the system. For the UL signals, it is recommended that each UL path contains no optical combining. Each UL optical transmitter should have a corresponding UL optical receiver. The combining of several UL signals can only normally be undertaken after the Fibre/RF conversion..) If UL combining is unavoidable (normally due to the lack of available fibre), it is necessary to convert Fibre/RF before mixing the different RF signals prior to a second RF/Fibre conversion. (Normally due to the lack of available fibre), it is necessary to convert Fibre/RF before mixing the different RF signals prior to a second RF/Fibre conversion.

WDM -Wave Division Multiplexing

WDM allows two optical signals to use the same Monomode fibre. This technique is generally used to allow the UL and DL signals to pass over the same fibre link. Each optical signal has a different wavelength, e.g. the DL signal could have a λ_{optic} of 1310 nm and the UL a λ_{optic} of 1550nm. As previously mentioned, care should be taken in the selection of the component parts to take into account the different optical wavelengths.

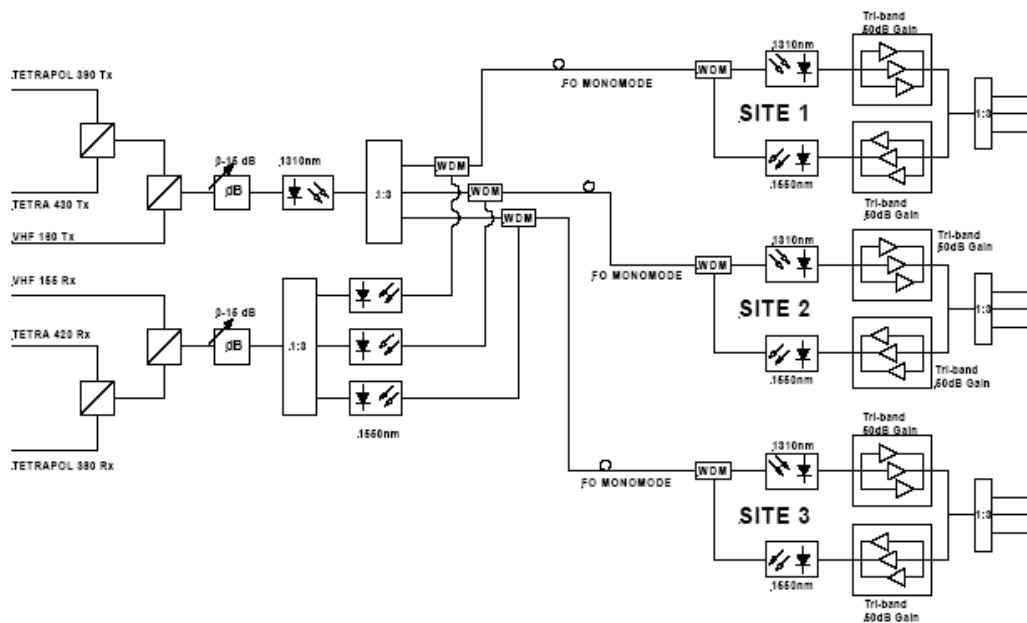
Base Station or Off Air Interface

The signals to be transported by the fibre need to be filtered, and in most cases attenuated before the conversion RF/Light. If the base station is available locally, the DL signals can be coupled off the antenna port and fed to the optical transmitter. If the base station is not available locally, a cell enhancer or repeater needs to be installed to capture the external signals prior to the RF/Light conversion. Similar techniques are applied for the UL signals. The RF signals from the fibre are either coupled into the antenna port of the base station or amplified by the repeater towards the external base station. Both the local base station interface and repeater can be supplied by DrawCom.

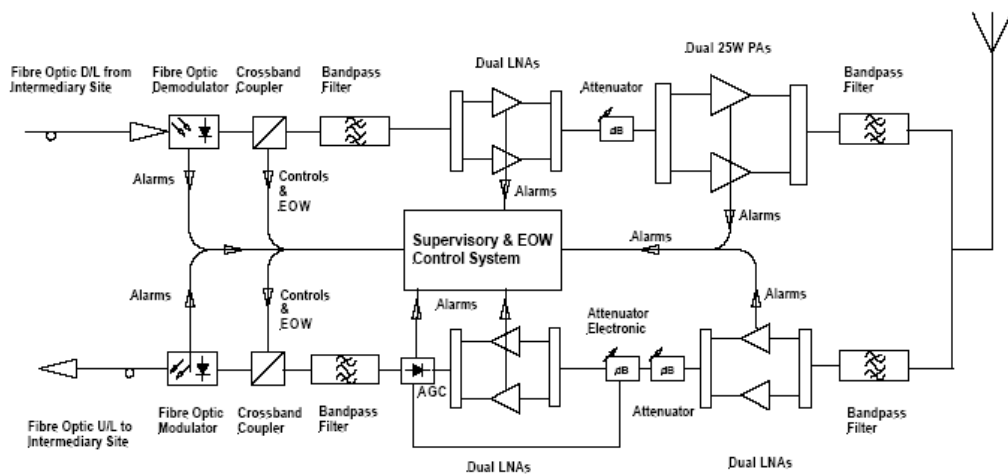
Fibre Optic Solutions (cont.)

RF Bandpass Filtering and Repeater Solutions

DrawCom can supply a number of broadband Fibre Optic solutions using bandpass and crossband filtering techniques which allows each band or channel to be individually amplified, thus maximising the output levels and the intermodulation characteristics. The AFL range of highly linear Class A amplifiers add the gain necessary to achieve the required power output levels. After amplification, each band can be combined to provide one or several output ports for the cable or antenna infrastructure. The AFL range of multi band channelised or band selective solutions use highly linear Class A PAs with OIP3s of +40 to +60 dBm.



System Solution WDM : 1 Master & 3 Slaves



FO Out Station Solution: UHF

Fibre Optic Solution (cont.)

Typical RF Specifications

RF Frequency Band	100 – 1000 MHz (Other bands available)
Maximum Input Power	0 dBm (PEP)
In Band Ripple	±1.5 dB
Typical Noise Factor	45 dB
Rx Gain	-20 to 0 dB
Rx Gain over the Band	±1.5 dB
OIP3 of Rx Output Amplifier	+ 26 dBm
Impedance	50 Ω
VSWR	Better than 1,5 : 1
Connectors	N or SMA

Typical Optical Specifications

Optical Wavelength	1310 or 1550 nm
Maximum Optical Power Output Tx	3 dBm optic
Maximum Optical Power Input Rx	1 dBm optic
Link Budget	9 dB optic (18 dB RF)
Optical Return Loss	60 dB
Rx Gain	-20 to 0 dB
Connectors	FC / APC

Typical Fibre Optic Cable Specifications

Fibre Type	Monomode
Attenuation / km	0.4 dB optic
Optical Connector Loss / mated pair	0.5 dB optic
Maximum Link Length	20 km

Options

WDM	Both λ on the same Fibre (1310 & 1550nm)	
Main & Standby	Transmitters & Receivers	
Alarms	Tx Alarm –	Laser Power O/P
		Laser Temperature
	Rx Alarm –	Low Received Signal I/P
Supervision	Supervision of the Fibre & Associated Systems with Local & Remote Access	
Engineer's Order Wire	Facilitates the Link Commissioning	
PSUs	Several Integrated or External Solutions	

















IP Dust and Water Protection Rating

This section provides a short overview and essentials of the classification. For more details, please refer to the latest original publication IEC 60529 (direct ordering or list of local sources via Internet www.iec.ch).

IP Rating (IP XY)

First number X - protection against ingress of solid objects

Second number Y - protection against ingress of water

0		no protection	0		no protection
1		protection against objects larger than 50 mm diameter	1		vertical dripping water
2		protection against objects larger than 12.5 mm diameter	2		dripping water, 15° tilted
3		protection against objects larger than 2.5 mm diameter	3		spraying water
4		protection against objects larger than 1.0 mm diameter	4		splash water
5		protection against dust (limited ingress, not harmful)	5		water jets
6		protection against dust (dust-tight, no ingress)	6		powerful water jets
			7		temporary immersion (test 1 m, 30 min.)
			8		continuous immersion (test to be agreed, but exceeding no. 7)