



City Wide Road Crossroads High Bandwidth MIMO WiFi Wireless Surveillance System Design

1. Planning purposes

Road intersection in city street light pole erection fast ball Speed Dome rotation monitoring cameras, through the MIMO WiFi wireless bandwidth transmission all monitor camera images back to the control center and to real-time monitoring and management of road traffic condition and pedestrian road crossing area.

2. Planning requirements

Long 6Km* wide 5Km within the city, in the erection of road crossing Speed Dome surveillance cameras, total will build up 34 Speed Dome.

Long 6Km* wide 5Km city-wide, horizontal six trunk, trunk of longitudinal 7 article, cross out of 42 crossing point, in which 34 main road set up Speed Dome at the crossroads.

34 fast ball Speed Dome rotation monitoring camera, is expected to produce $34 \times 3.5\text{Mbps} = 119\text{Mbps}$ transmission bandwidth requirements during the day, at night $34 \times 5\text{Mbps} = 170\text{Mbps}$ transmission bandwidth requirements. **Total planning wireless link bandwidth must be more than $170\text{Mbps} \times 130\% = 221\text{Mbps}$ above.**

By horizontal six major roads, vertical 7 main road, cross out of 42 intersection point, need to plan at least 2 wireless backbone links, through multipoint hops relay platform technology, 34 Speed Dome camera image bandwidth need to integration brings together and transport to control center for monitoring and managing.

If the shelter effect of road trees on wireless transmission of signals, building on each side if necessary to set up a hop relay platform for wireless devices to avoid trees shielding attenuation and blocked.



3. Set up environment and camera mapping





4. MIMO WiFi wireless backbone transmission design (consider the trees cover the wireless signal problem)

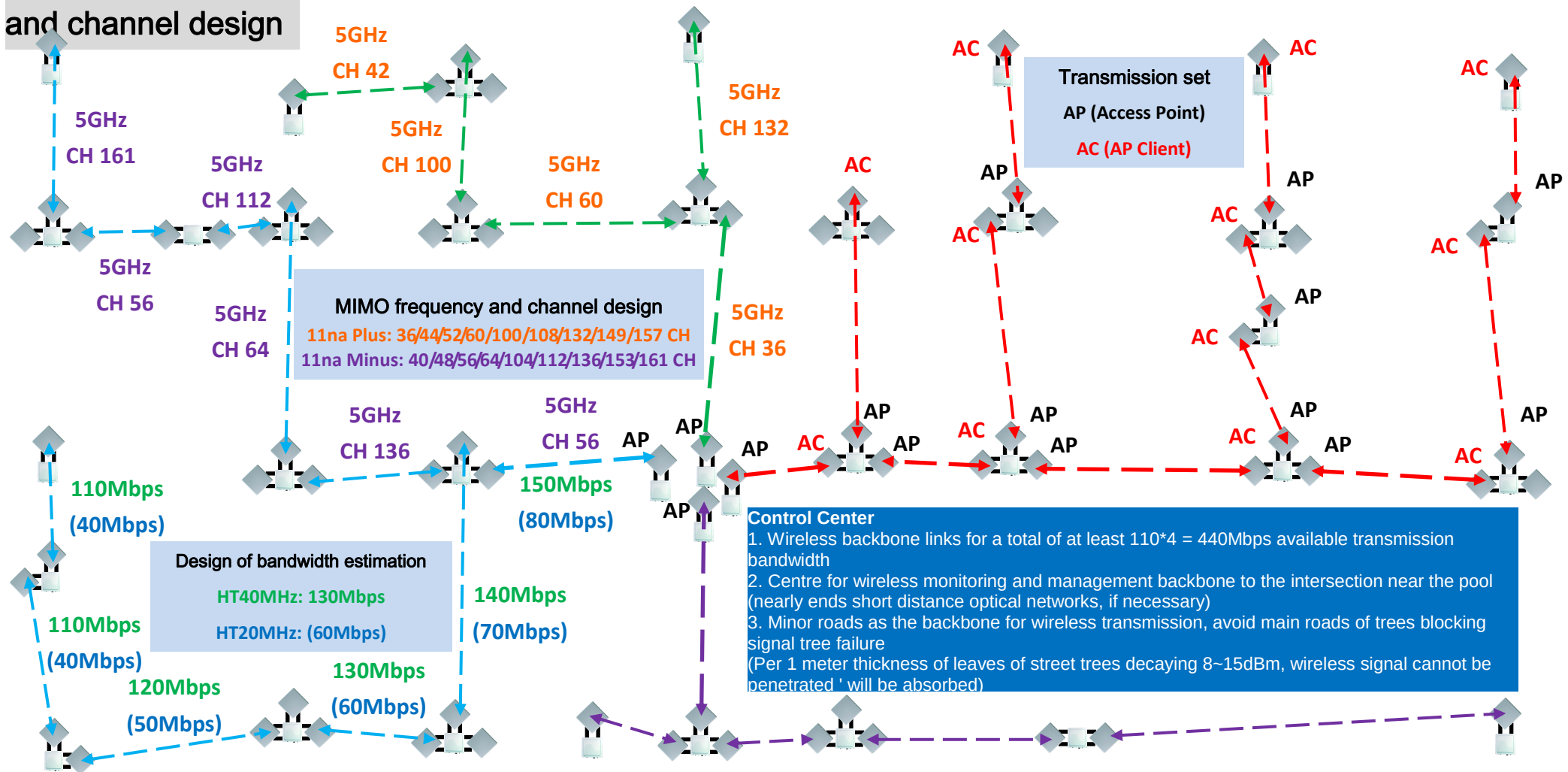


Wireless systems design guide: 1. design of multiple hops relay platform to not more than 6 jumped 2.The basis for the design, each wireless backbone links to no bandwidth over 60Mbps for design requirements 3. In the erection of three forks or crossroads, 103R three wireless module designs, reserved engineering change link direction to set up or increase future links to expand or equipment upgrade needs.



5. MIMO WiFi wireless backbone transmission module, set design and frequency and bandwidth estimation

and channel design



Wireless bandwidth prediction commentary: 1. the multiple hops relay platform technology, 1th hop 140~160Mbps, 2nd hops 130~150Mbps, 3rd hops 120~140Mbps, 4th hops 110~130Mbps, 5th hops after to maintain 110~120Mbps bandwidth, lower bandwidth will not increase the number of platform and response time not less than 10ms.



6. Estimated mounted devices

No.	Device Name	Model	Main SPEC	Amount (Unit)	Remark
1	Outdoor Wireless AP -(AP Client-Camera)	APM-101R (1 RF Module)	1. One MIMO 2*2 RF Module (802.11a/g/n) 2. System Operation Mode: Bridge 3. Output Power : 21dBm (Max) 4. Multiple Hops >= 4Hops Throughput 120MHz 5. Bandwidth Throughput : 180Mbps (@40MHz) 6. Special Features : Multiple Hopping	13	Suggest purchase 15
2	Outdoor Wireless AP -(Backbone hops relay)	APM-102R (2 RF Module)	1. Two MIMO 2*2 RF Module (802.11a/g/n) 2. System Operation Mode: Bridge 3. Output Power : 21dBm (Max) 4. Multiple Hops >= 4Hops Throughput 120MHz 5. Bandwidth Throughput : 320Mbps (@40MHz) 6. Special Features : Multiple Hopping	6	
3	Outdoor Wireless AP -(Backbone Pool-side)	APM-103R (3 RF Module)	1. Three MIMO 2*2 RF Module (802.11a/g/n) 2. System Operation Mode: Bridge 3. Output Power : 21dBm (Max) 4. Multiple Hops >= 4Hops Throughput 120MHz 5. Bandwidth Throughput : 320Mbps (@40MHz) 6. Special Features : Multiple Hopping	18	Suggest purchase 20
4	MIMO AP Antenna – Panel High Gain	IOP-PANFO -5M2001010	1.Frequency: 5150 - 5875 MHz 2.Gain: 20dBi 3.VSWR: 2:1 4.Polarization : Dual Linear +- 45° 4.H:10° / V:10° 5.N-Type Jack * 2 6.Front to Back: -30dB 7.Isolation: 24dB 8.Weight: 1.24Kg	79	Suggest purchase 80
5	CFD400 1.5M	IOP-RFCFD	1. Connector N-Type Male Cable Loss value is needed	158	Suggest



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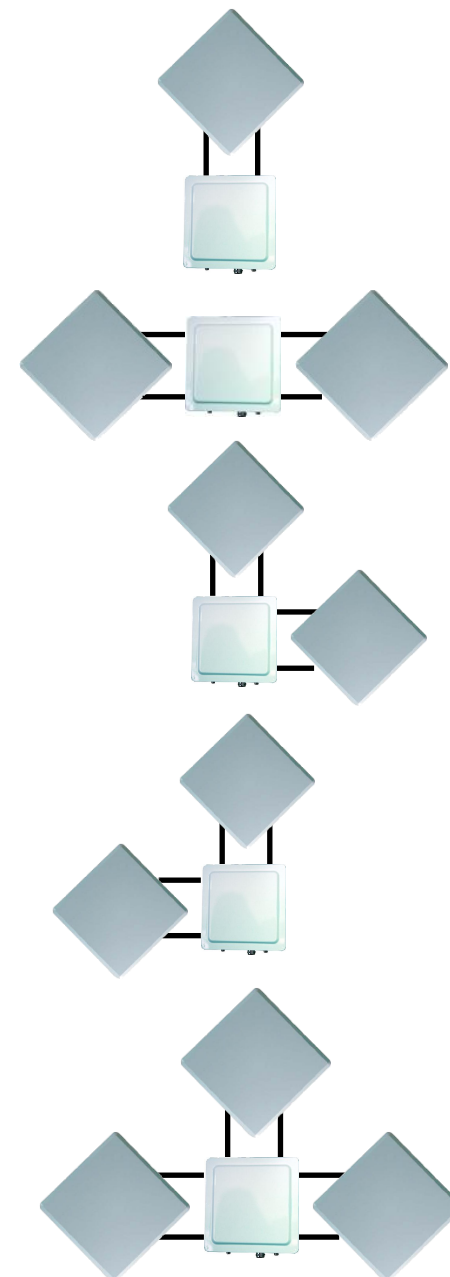
<http://www.io-power.com> e-mail: io-power@io-power.com.tw Tel: 886 3 5429395 Fax: 886 3 5357297 Cell: 0933168849

	RF Cable	-400150NMR	2.5800MHz than 48dB/100m 3.-40 °C ~ 85 °C		purchase 160
6	Self-Bonding Rainproof Insulating Tape	IOP-RMTOC -173830510B	Tensile breaking force of at least 2Kg, adhesion / split: 2cm, black, thickness: 1.7mm 0.2% for 0.5mm water absorption, stability of 130 degrees centigrade / 100hrs does not gum, elongation by more than 1000%	40	



7. Device type and specifications

Product Images	Model	APM-101R (H)	APM-102R (H)	APM-103R (H)
	Rear Side			
	Top of Antenna Connector			
	Below of Antenna Connector			
	Front Side			





Product Specifications

Hardware Specification

Key Components	
Main Processor	Atheros AR7161(680Mhz)
Wireless Chipset	Atheros AR9220 based miniPCI module, Up to three modules
Switch Controller	Atheros AR8035 / Atheros AR8021
Flash Memory	16MBytes
SDRAM	128MBytes
Console	UART x 1(PCBA onboard)

Interfaces	
Wireless	Up to three 2x2 MIMO radios, mini-PCI version 1.0 type 3A Frequency ranges : a. USA : 2.400 ~ 2.483 GHz, 5.15 ~ 5.35 GHz, 5.5 ~ 5.7 GHz, 5.725 ~ 5.825 GHz b. Europe: 2.400 ~ 2.483 GHz, 5.15 ~ 5.35 GHz, 5.47 ~ 5.725 GHz



c. Japan: 2.400 ~ 2.497 GHz, 5.15 ~ 5.35 GHz, 5.47 ~ 5.725 GHz

d. China: 2.400 ~ 2.483 GHz, 5.725 ~ 5.85 GHz

RF output power of DNMA-92 :

a. IEEE802.11a

1. 21dBm@6M(all) 17dBm@54M(5180MHz) 16dBm@54M(5825MHz)

b. IEEE802.11b

1. 20dBm@1M(2412MHz) 19dBm@1M(2484MHz) 21dBm@11M(all)

c. IEEE802.11g

1. 23dBm@6M(all) 19dBm@54M(all)

d. IEEE802.11a/n HT20

1. 21dBm@MCS0/8(5180MHz) 19dBm@MCS0/8(5825MHz)

2. 16dBm@MCS7/15(5180MHz) 14dBm@MCS7/15(5825MHz)

e. IEEE802.11a/n HT40

1. 19dBm@MCS0/8(5190MHz) 18dBm@MCS0/8(5795MHz) 13dBm@MCS7/15(all)

f. IEEE802.11g/n HT20

1. 21dBm@MCS0/8(all) 17dBm@MCS7/15(all)

g. IEEE802.11g/n HT40

1. 21dBm@MCS0/8(2422MHz) 20dBm@MCS0/8(2462MHz)



2. 16dBm@MCS7/15(all)

Receive Sensitivity of DNMA-92 :

a. IEEE802.11a

1. -82dBm@6M, 1Rx -95/-91dBm@6M, 2Rx 2. -65dBm@54M, 1Rx -79/-75dBm@54M, 2Rx

b. IEEE802.11b

1. -82dBm@1M, 1Rx -95/-91dBm@1M, 2Rx 2. -76dBm@11M, 1Rx -91/-87dBm@11M, 2Rx

c. IEEE802.11g

1. -82dBm@6M, 1Rx -95/-91dBm@6M, 2Rx 2. -65dBm@54M, 1Rx -80/-76dBm@54M, 2Rx

d. IEEE802.11a/n HT20

1. -82dBm@MCS0, 1Rx -95/-91dBm@MCS0, 2Rx 2. -64dBm@MCS7, 1Rx -77/-73dBm@MCS7, 2Rx

e. IEEE802.11a/n HT40

1. -79dBm@MCS0, 1Rx -91/-87dBm@MCS0, 2Rx 2. -61dBm@MCS7, 1Rx -74/-70dBm@MCS7, 2Rx

f. IEEE802.11g/n HT20

1. -82dBm@MCS0, 1Rx -95/-91dBm@MCS0, 2Rx 2. -64dBm@MCS7, 1Rx -77/-73dBm@MCS7, 2Rx

g. IEEE802.11g/n HT40

1. -79dBm@MCS0, 1Rx -90/-86dBm@MCS0, 2Rx 2. -61dBm@MCS7, 1Rx -74/-71dBm@MCS7, 2Rx

Ethernet

10/100/1000 Base-TX MDI/MDIX RJ-45 x 1

Compliant with :



	a. IEEE802.3 / 802.3u / 802.3at Hardware based 10/100/1000, full/half, flow control auto negotiation
Connector	101R 2 x N-type(1 radio) 102R 4 x N-type(2 radios) 103R 6 x N-type(3 radios)
Power Requirement	48V 1A PoE Support Gigabit Ethernet Link
Watch Dog	Hardware Watch Dog

Physical	
Dimensions	220 x 220 x 77 mm
Weight	101R/101RH—1.8Kg 102R/102RH—1.9Kg 103R/103RH—2.0Kg 2.0kg (3.7kg mount kit included)

Environmental	
Temperature Range	-20°C~70°C



Humidity	0% ~ 95% Non-condensing
Storage	-40~ 85°C
Dusty & Waterproof	Outdoor IP67 rated

Regulatory	
Certification	FCC, CE
Safety	Processing

Software Specification

System Operation	
Bridge Mode	Layer 2 Switching Learning Technology
	Store-and-Forward
	Spanning Tree Protocol - IEEE 802.1d STP / IEEE 802.1w RSTP / IEEE 802.1s MSTP
	Static IP / Dynamic IP
	DHCP server / client



	Multicast / Broadcast Storm Limitation
	IEEE 802.1q Tag VLAN
	IEEE 802.1p VLAN Priority Based QoS

Network Interface	
Wireless	IEEE 802.11 a/b/g/n 2.4GHz / 5GHz Dual Band Radio
	2 x 2 MIMO Technology
	Single Radio / Dual Radios / Triple Radios
	AP mode / Client mode / WDS mode
	IEEE 802.11h DFS
	WMM QoS
	Channel / Tx Power / Data Rate / Max Distance Adjustable
	Advanced Wireless Parameters Adjustable



	Multi-SSIDs / VLAN tags mapping(Up to 16 x ESSIDs for each radio)
	Wireless Site Survey
	Node Information
	Concurrent Connected Node Limitation
	Client User Isolation
Wire	48V 1A PoE Support Gigabit Ethernet Speed
	Ethernet Link Speed Configurable
	10/100/1000 Base-TX MDI/MDIX RJ-45

Performance

Wireless	TCP	Up to 180Mbps for one radio to Ethernet
To		Up to 320Mbps for two radios to Ethernet
Wire		Up to 320Mbps for three radios to Ethernet



	UDP	Up to 240Mbps for one radio to Ethernet
		Up to 350Mbps for two radios to Ethernet
		Up to 350Mbps for three radios to Ethernet
	PPS	$\geq 20,000$ @short packet for one radio to Ethernet
		$\geq 28,000$ @short packet for two radios to Ethernet
		$\geq 28,000$ @short packet for three radios to Ethernet
	Latency	$< 5\text{ms}$
Multiple Hops	2 hops	Up to 160Mbps
	3 hops	Up to 150Mbps
	$\geq 4\text{hops}$	Up to 140Mbps
	PPS	$\geq 20,000$ @short packet at multiple hops
	Latency	$< 10\text{ms}$



Security

Hide SSID(turn off ESSID broadcasting)

MAC Address ACL

WEP 64/128/152 bits

IEEE 802.1x EAP-MD5 / EAP-TLS / EAP-TTLS

WPA / WPA2 PSK / EAP with TKIP / CCMP AES based Encryption

Management

HTTP(s) WEB GUI

Telnet

SSH

Console(optional interface)

CLI commands

SNMP v2c/v3, standard / private MIBs



Syslog

Management VLAN Tag

NTP Client

Firmware upgrade / downgrade

Dual Images

Dual Configuration files / Factory Default

Multiple Level Management

Advanced Technology

Multiple Hopping

Up to 10 hops with more than 120Mbps throughput

Configurable Max. Hop Counts(default 20 hops)



IOP-PANFO-5M2001010

5GHz 20dBi Dual Polarization MIMO Panel Antenna

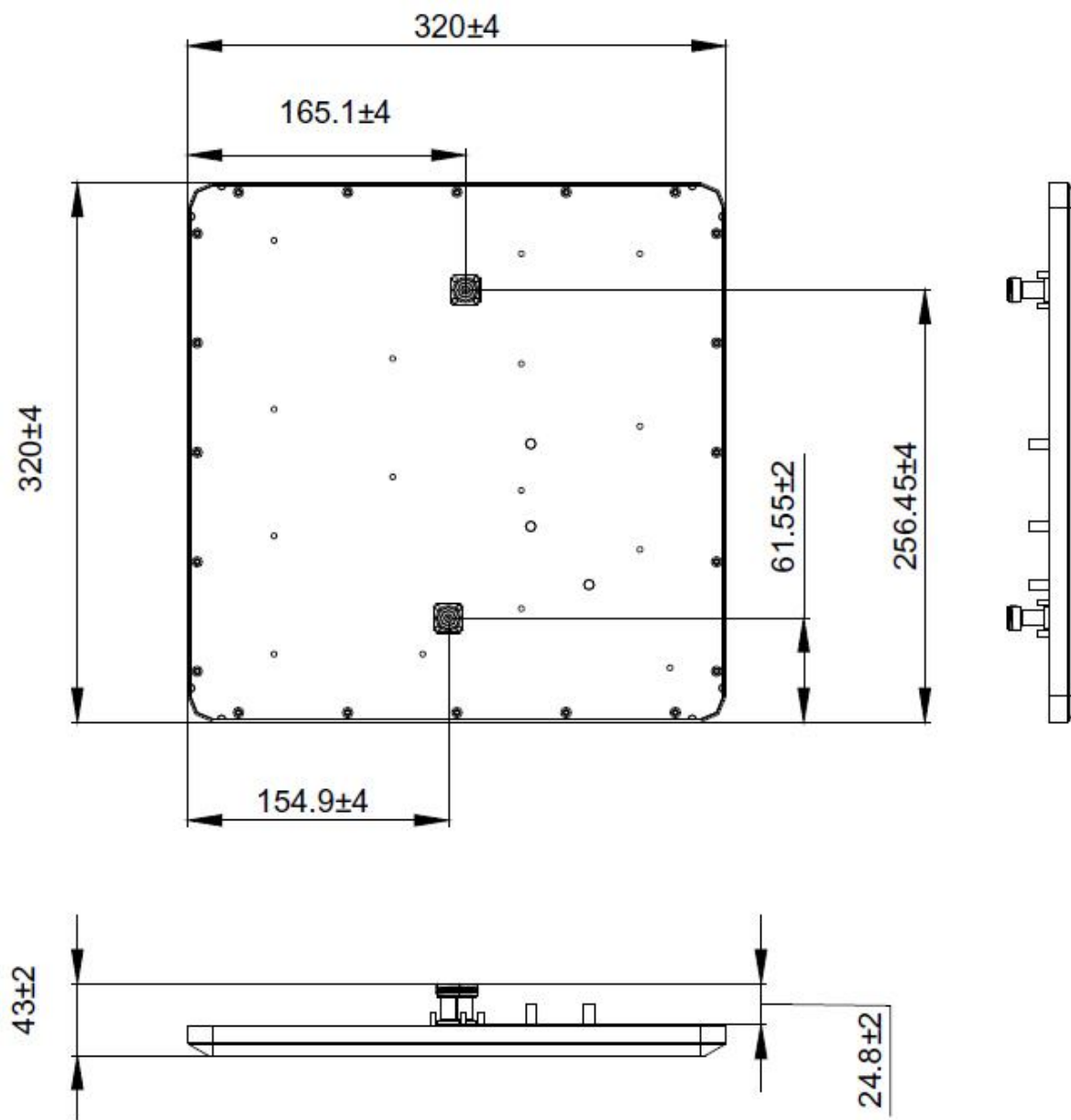
Electrical Specification	
Frequency range	5150 - 5875 MHz
Gain	20 dBi
VSWR	2 : 1 Max.
Polarization	Dual Linear, +- 45°
HPBW / Horizontal	10°
HPBW / Vertical	10°
Standard compliance	N / A
Front to back ratio	-30dB (Max)
Isolation	24dB (Min)
Power handing	6W (cw)





Impedance	50 Ohms
Connector	N Jack × 2
Environmental & Mechanical Characteristics	
Survival wind speed	216Km/hr
Temperature	-40°C to +80°C
Humidity	95% @ 55°C
Lightning protection	DC ground
Radome color	Gray
Radome material	PC, UV resistant
Weight	1245g
Dimensions	320 × 320 × 20 mm
Waterproof	IP-67
Mounting kit	Pole mount & Wall mount

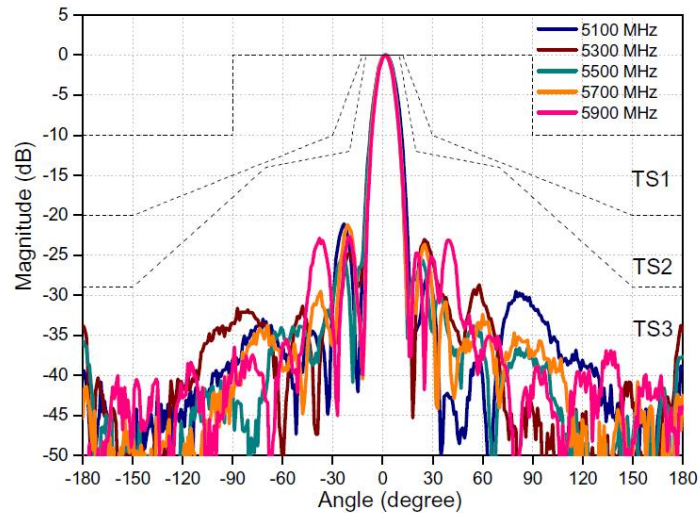
*exclusive of mounting kit



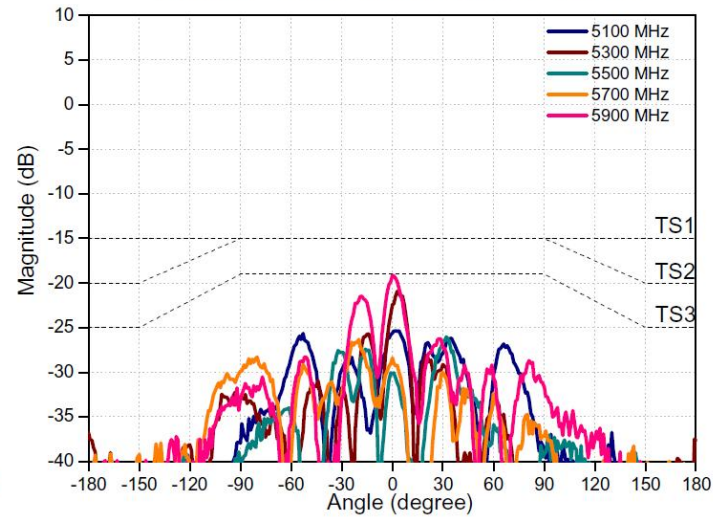


Port 1

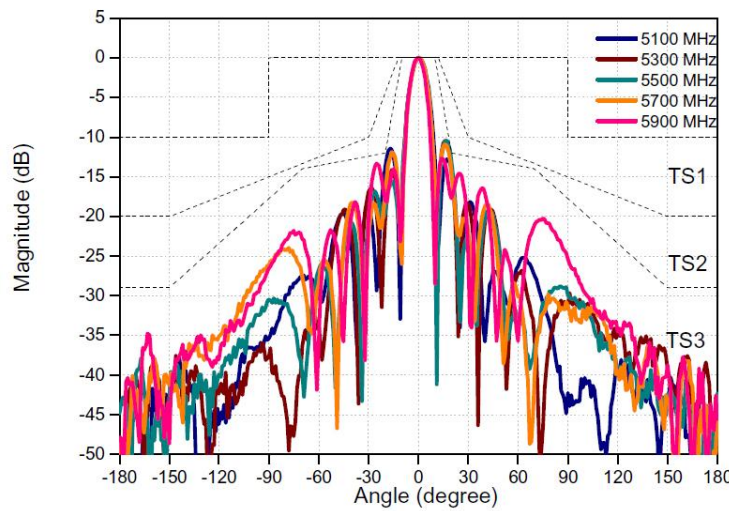
V-plane Co-polarization Pattern



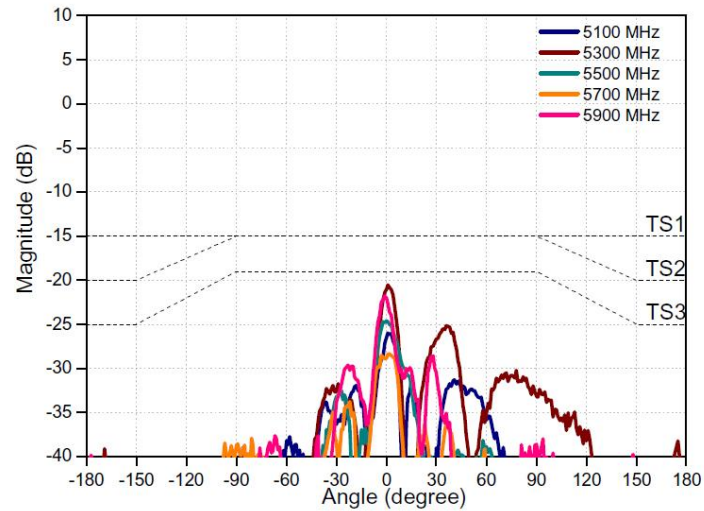
V-plane Cross-polarization Pattern



H-plane Co-polarization Pattern



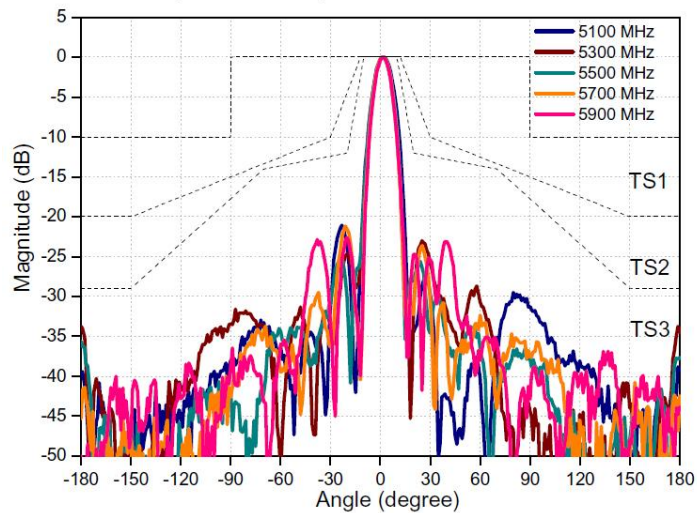
H-plane Cross-polarization Pattern



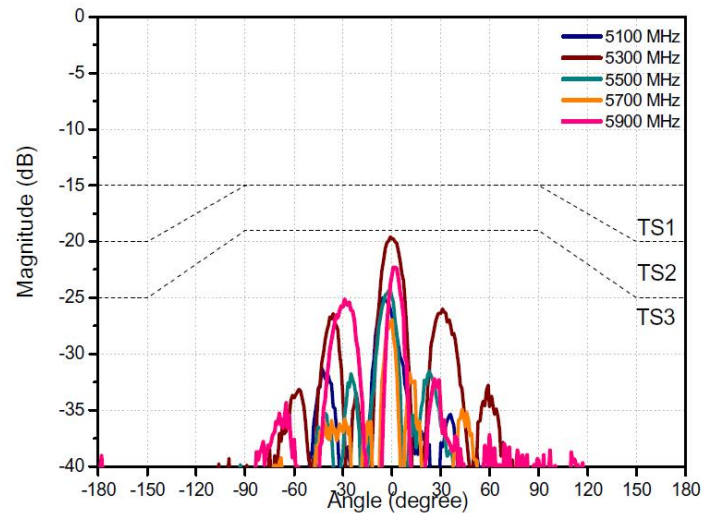


Port 2

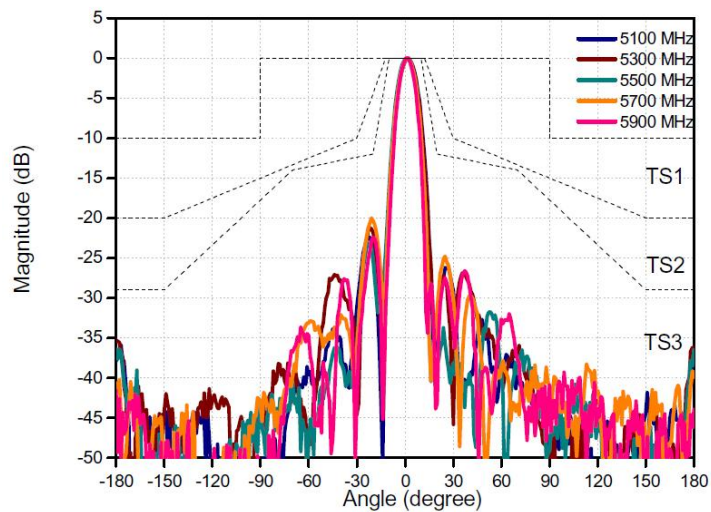
V-plane Co-polarization Pattern



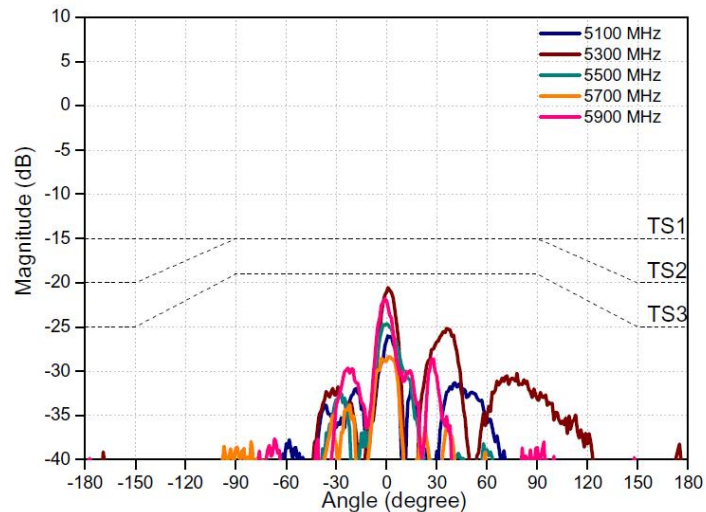
V-plane Cross-polarization Pattern



H-plane Co-polarization Pattern



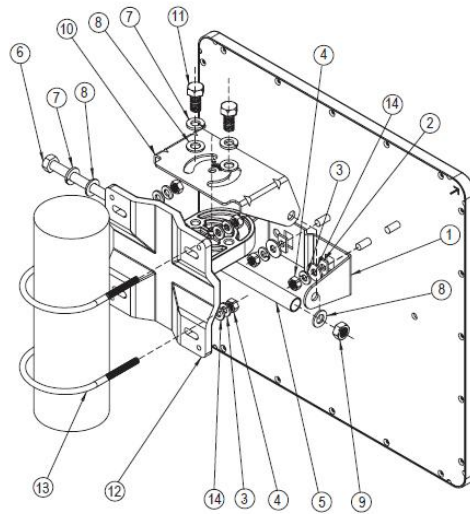
H-plane Cross-polarization Pattern



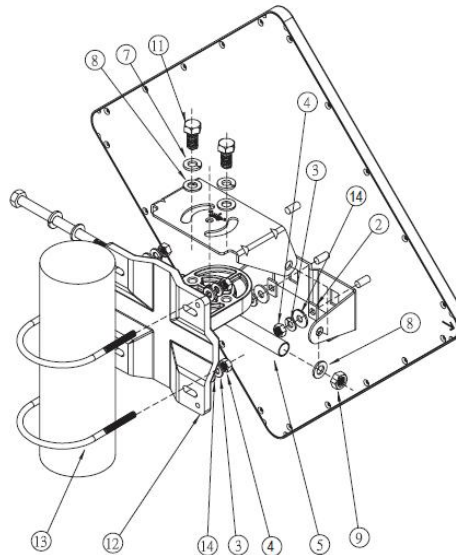


Pole Mount

Slant±45 Degree Polarization



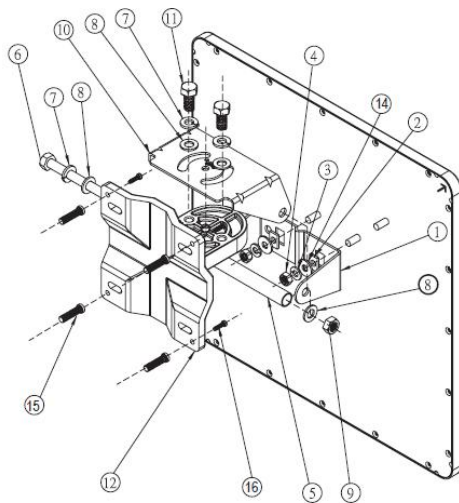
Hor. & Ver. Polarization



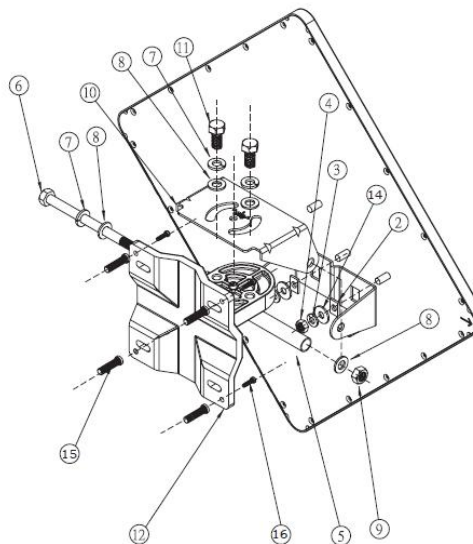
- | | |
|------------------------|------|
| 1. M-Type breaket (L) | 1Pcs |
| 2. Space Keeper | 2Pcs |
| 3. Spaing washer | 6Pcs |
| 4. M6-1.0 Nut | 6Pcs |
| 5. Steel tube 93.2 mm | 1Pcs |
| 6. XHM8-1.25*120 | 1Pcs |
| 7. M8 spring washer | 3Pcs |
| 8. M8 washer | 4Pcs |
| 9. M8 Nut | 1Pcs |
| 10. Rotating bracket | 1Pcs |
| 11. XHM8-1.25*20 | 2Pcs |
| 12. Mounting main fram | 1Pcs |
| 13. U-Type Screw | 2Pcs |
| 14. M6 washer | 6Pcs |
| 15. Wall Tiger | 4Pcs |
| 16. TH 5/32-16*1" | 4Pcs |

Wall Mount

Slant±45 Degree Polarization



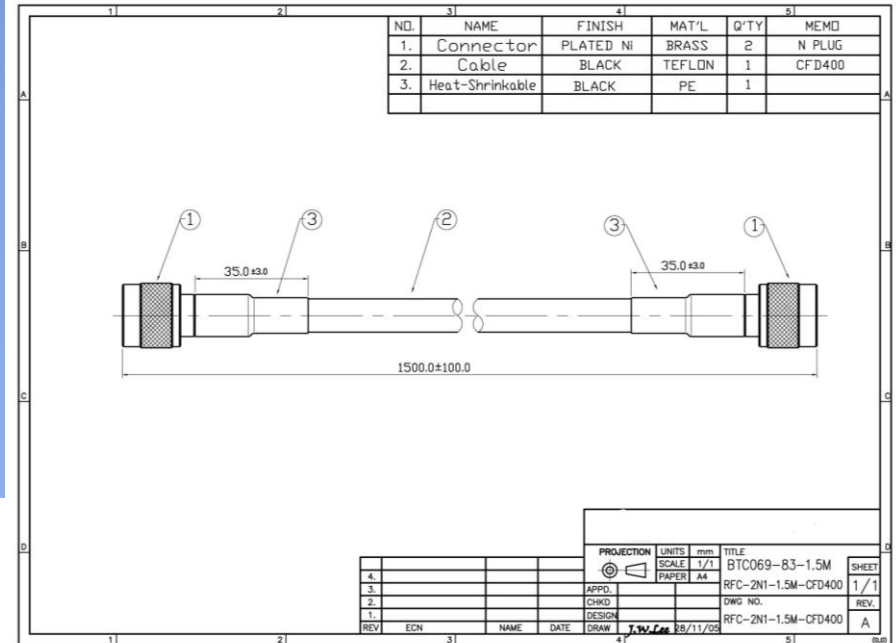
Hor. & Ver. Polarization





IOP-RFCFD-400150NMR

CFD-400 N-Type 1.5M Antenna RF Cable





CFD-400 RF Cable SPEC

Standard: CFD400 (CFD400-E) CABLE 1/2.74MM X 1C

CONSTRUCTION:

ITEM		UNIT	2.74MM
No. of Wire		P · C	1C
1) Conductor	Material	—	Copper Clad Aluminium
	Size	No. /mm	1/2.74
2) Insulation	Material	—	PEF
	Thickness	mm	(NOM.) 2.2
	O.D	mm	(NOM.) 7.24
3) Binder		—	Sealed Aluminum Mylar Tape
4) Braid Shield	Material	—	Tinned Copper Wire
	Coverage	%	85% ↑
5) Jacket	Material	—	PVC or PE
	O.D	mm	10.3+/-0.25

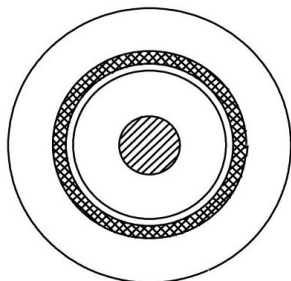
MECHANICAL PROPERTIES:

ITEM	UNIT	
Minimum Bend Radius	mm	25.4
Weight	kG/m	0.1
Tensile strength	kG	72.6
Operating temperature	°C	-40/85

ELECTRICAL PROPERTIES (20°C):

ITEM	UNIT	
Conductor Resistance	Ω /Km	1.67
Impedance	Ω	(NOM.) 50
Capacitance	PF/FT	(NOM.) 23.9
Velocity of propagation	%	(NOM.) 85
DC resistance, inner cond.	Ω /Km	4.56
DC resistance, outer cond.	Ω /Km	5.41
Shielding effectiveness	dB	≥ 90

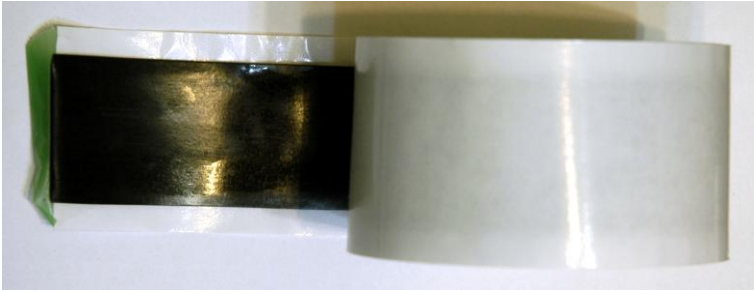
Attenuation (nom.)	
MHz	dB/100ft
30	0.7
50	0.9
150	1.5
450	2.7
900	3.9
1500	5.1
2000	6.0
2500	6.8
5800	10.8





IOP-RMTOC-173830510B

Self-Bonding Rainproof Insulating Tape SPEC





Specifications and instructions for use

1. The scope of:

- 600V Low-voltage connector used for sealing and insulation
- High and low voltage bus of anti-corrosion protection, maintenance of high pressure joints of waterproofing treatment

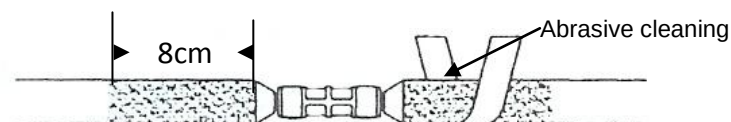
2. Conditions of use:

- Environment temperature is below 40 °C
- Continuous operating temperature: 90 °C below 130 °C under low pressure overload and emergency operation linkage PE joints of copper or aluminum cables.

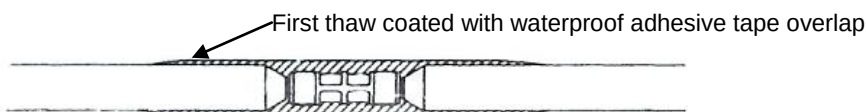
3. Characteristics:

- Voltage level : 600V
- AC voltage : Above 25KV
- Insulation resistance : $1 \times 10^6 \text{M}\Omega$
- Black, thickness : $1.7\text{mm} \pm 0.5\text{mm}$
- Adhesion/split : Below 2cm
- Extension rate : Above 1000%
- Tensile breaking force : Above 2Kg
- Water absorption : Below 0.2%
- Stability : 130°C/100hrs No gum

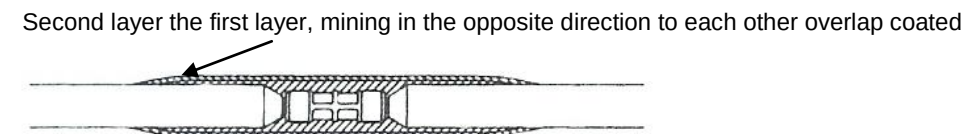
4. Instructions for use: With low-voltage cable straight connector as an example



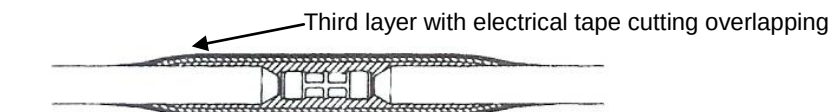
Step 1: abrasive cleaning at the both ends of the cable connectors and covered 8cm



Step 2: using thawed waterproof tape coated joints and covered on average 8cm



Step 3: use thaw average coated joints overlapped each other waterproof tape and covered 10cm



Step 4: finally uses the common PVC tape (electrical tape) overlap each other last average coating 12cm