

Leading Company, ACEWAVETECH

Portable PIM Analyzer

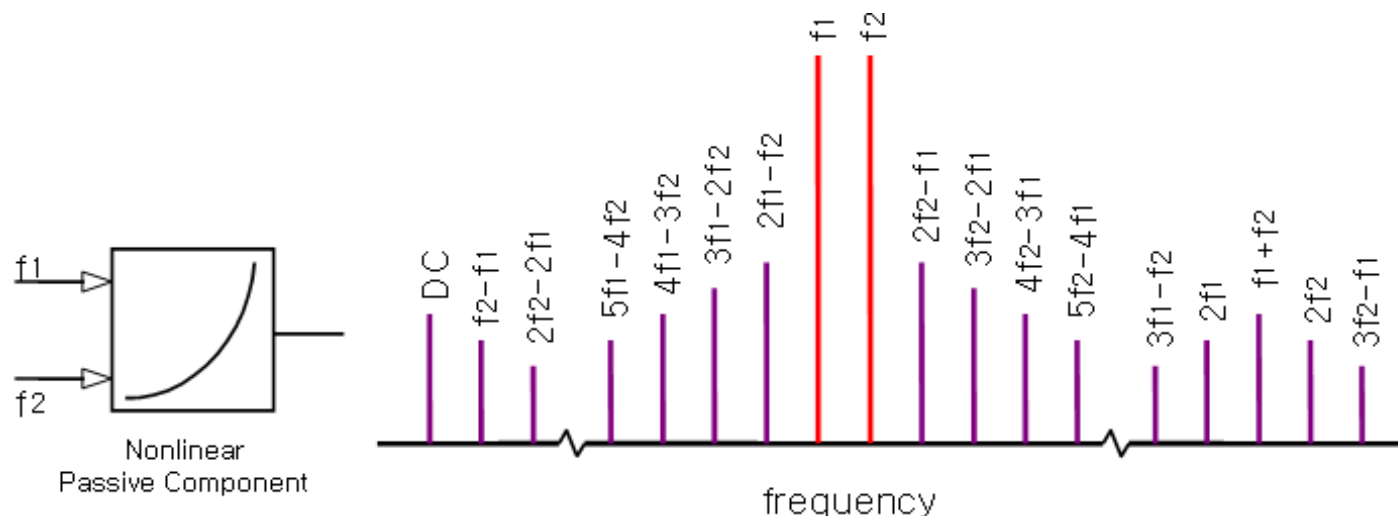
09. February. 2015



-  **1 PIM Scope** 
-  **2 AWT PIM Analyzer Review** 
-  **3 AWT PIM Analyzer Specifications** 
-  **4 AWT PIM Analyzer Characteristics** 
-  **5 Q & A** 

❖ PIM ? (Passive Inter-Modulation distortion)

- **PIM distortion** is caused by non-linear mixing of two or more frequencies in passive devices like cables and connectors



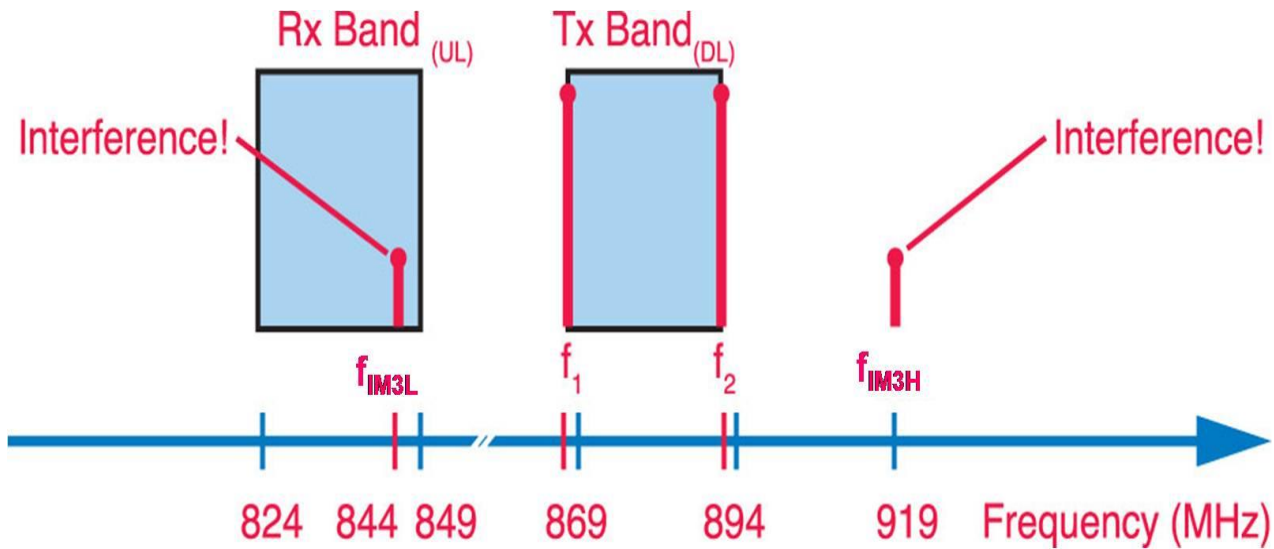
➤ IMD Equation

$$f_{\text{IMD}} = nf_1 - (n-1)f_2 \quad n: \text{integer}$$

1. PIM Scope



❖ PIM Signal



❖ What causes PIM

● Contact Nonlinearity

- Junction capacitance by oxidization between metal conductors
- Micro space between metal and by micro crack of metal
- Particles of metal surface and non-linearity of metal

● Material Nonlinearity

- Magnetic Material - Nickel, Steel, Cobalt so on
- Thermal Heating by heat conductivity of metal

❖ What causes PIM

● Manufacturing & Design

- Use of ferromagnetic materials
- Contaminations
- Corrosion and insufficient contact pressure
- Dissimilar metals at contact areas
- Insufficient thickness of plated metal
- Bad solder joints

● Mechanical

- Poor mechanical alignment of components
- Too much or too little torque at connections
- Contaminated connector

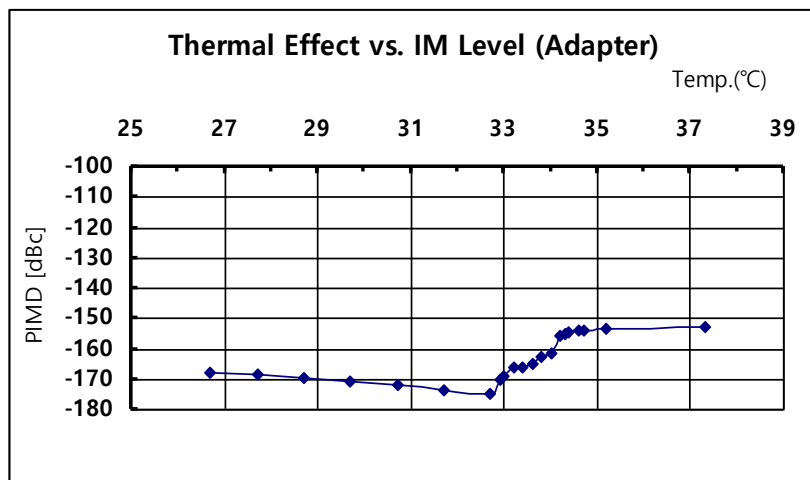
❖ What causes PIM

● Environment

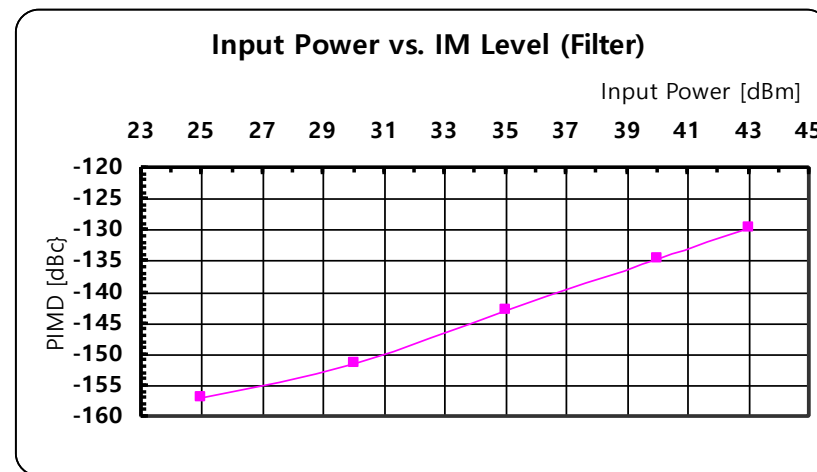
- Daily temperature variations
- Vibration
- Oxidation of Material

❖ Research Example of PIM

➤ Thermal Effect



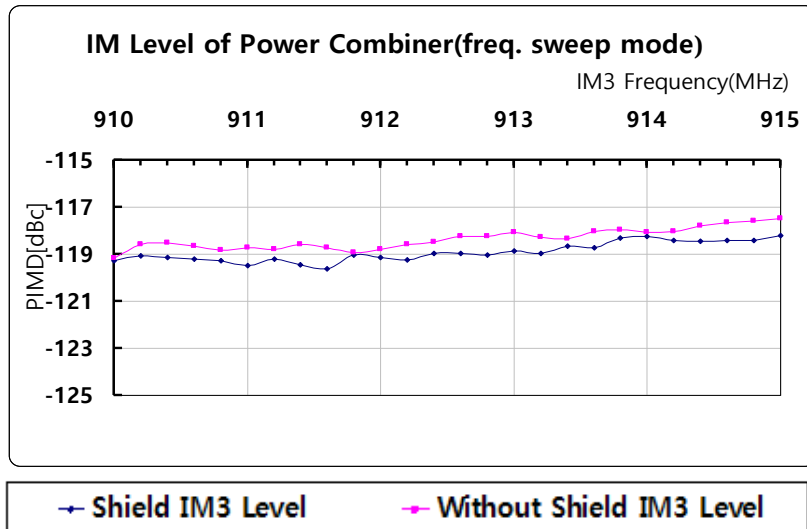
➤ Input Power



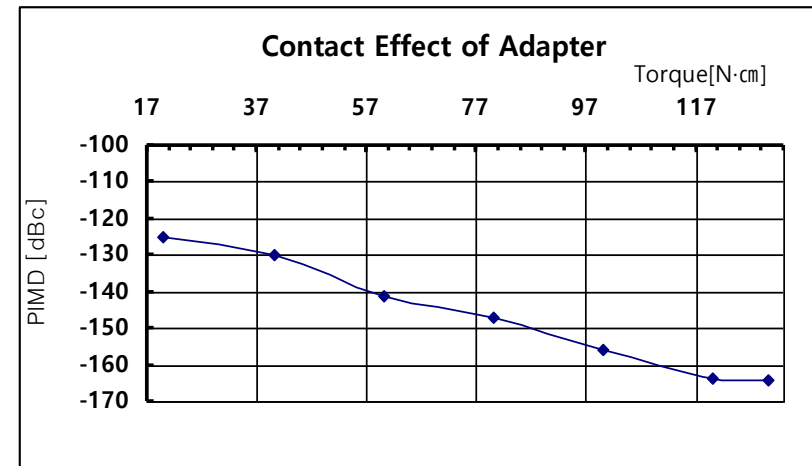
[Reference] ETRI, "RF 부품의 Passive IMD 측정 절차서"

❖ Research Example of PIM

➤ EMI Effect



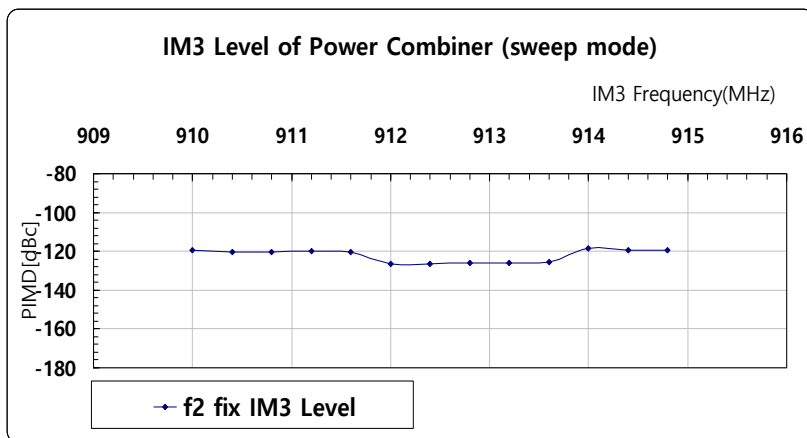
➤ Contact Effect



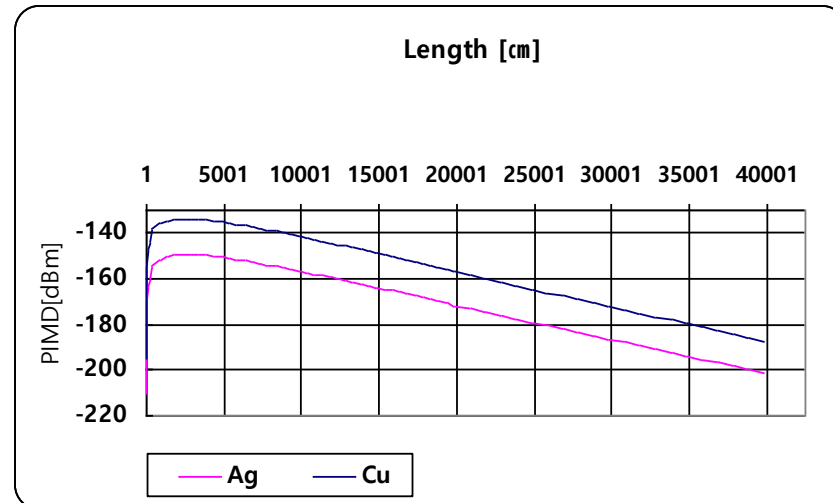
[Reference] ETRI, "RF 부품의 Passive IMD 측정 절차서 "

❖ Research Example of PIM

➤ Frequency Sweep



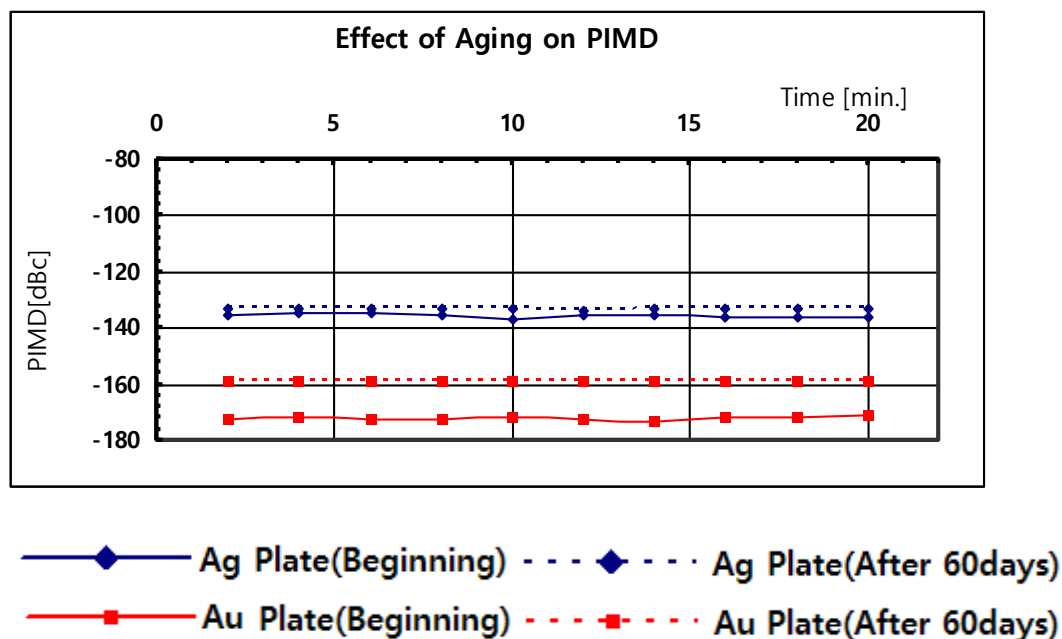
➤ Material



[Reference] ETRI, "RF 부품의 Passive IMD 측정 절차서 "

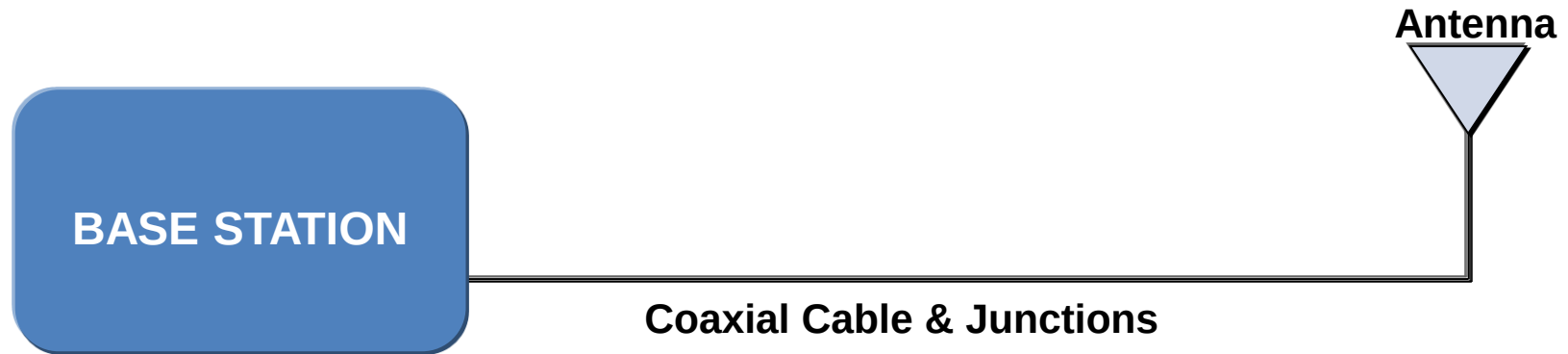
❖ Research Example of PIM

➤ Oxidization Aging



[Reference] ETRI, "RF 부품의 Passive IMD 측정 절차서 "

❖ VSWR and PIM TEST



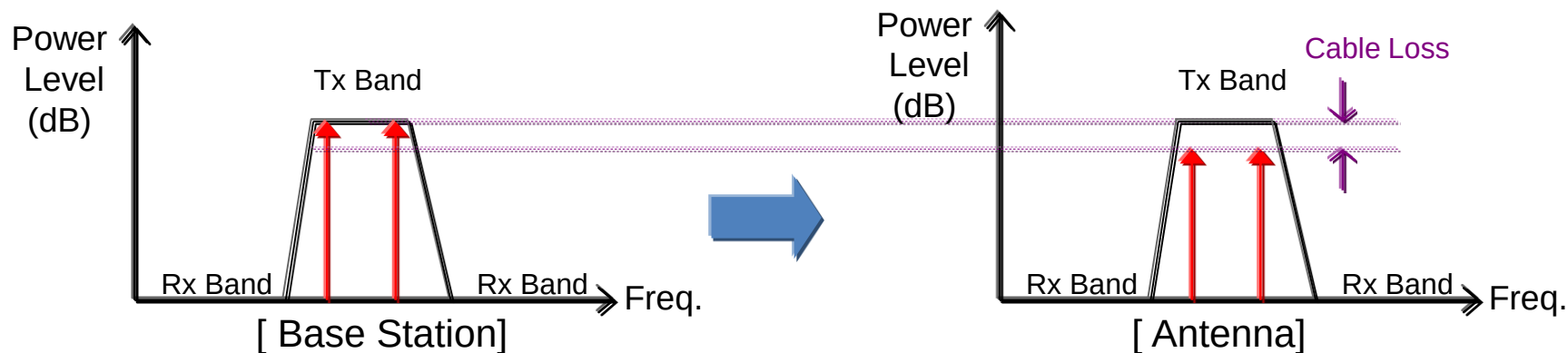
< Network system structure >

- In order to verify electrical characteristics of RF path in your network systems , it is recommended the VSWR test first. After VSWR test, it is also recommended to measure the interference like unwanted PIM level in your network systems. Recently, those 2 tests(VSWR test and PIM test)) are carrying out in real sites according to the requests from the operators.

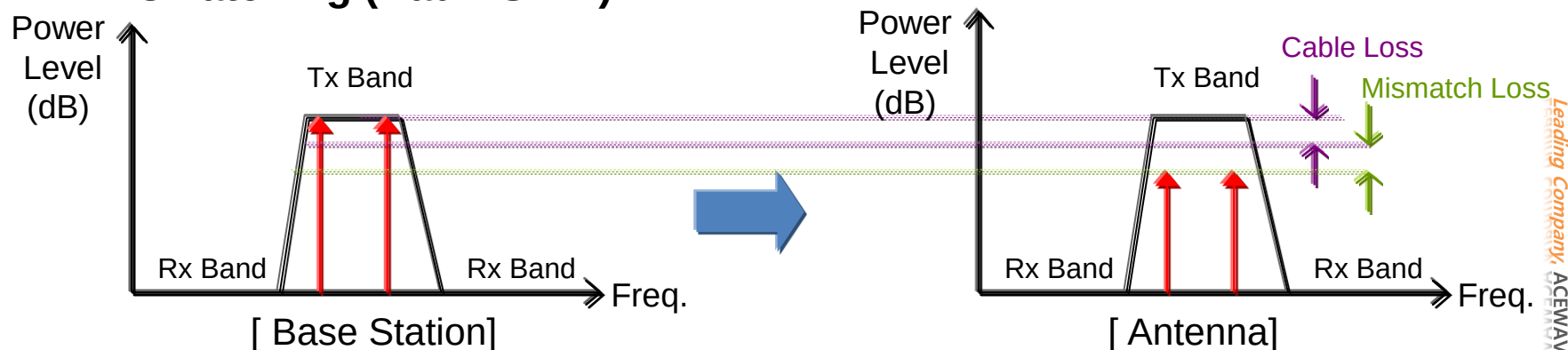
1. PIM Scope

❖ No-PIM

● Perfect Matching (Good VSWR)



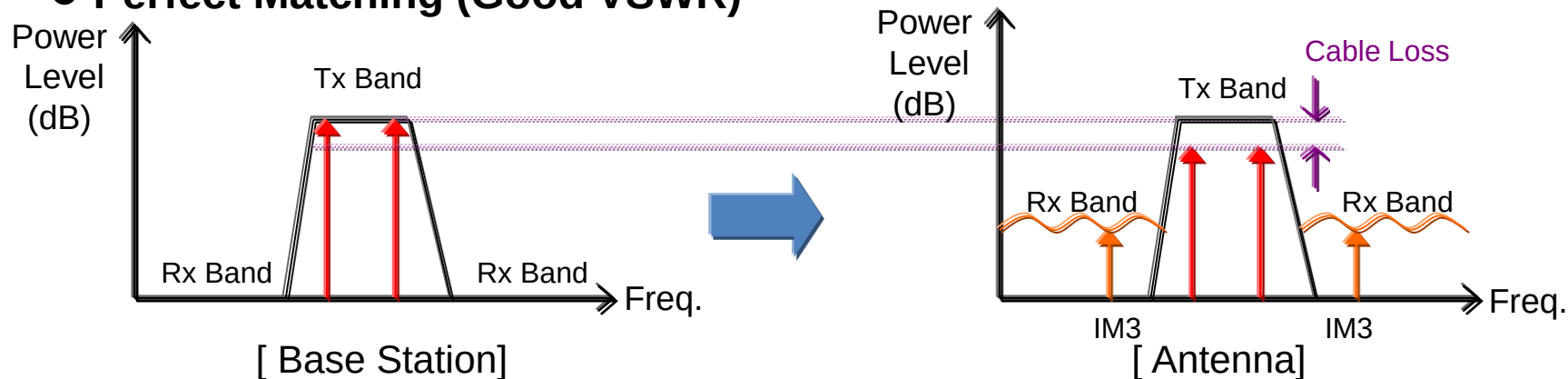
● Mismatching (Bad VSWR)



- Mismatch decrease transmitting Power

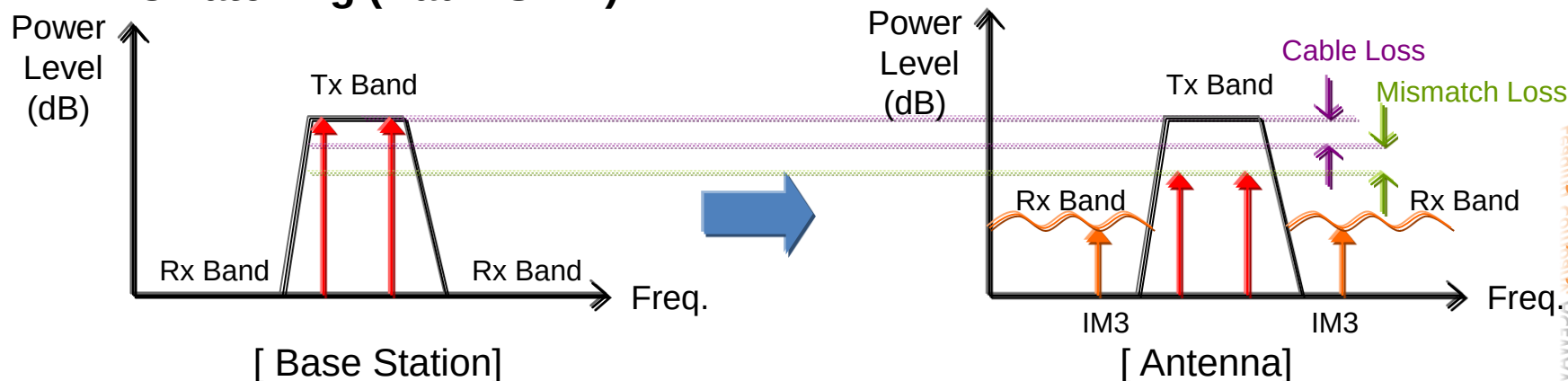
❖ Generated PIM

● Perfect Matching (Good VSWR)



- PIM increased noise level in Rx channel

● Mismatching (Bad VSWR)



- PIM increased noise level in Rx channel

- Mismatch decrease transmitting Power

2. AWT PIM Analyzer Review



❖ Portable PIM Shape

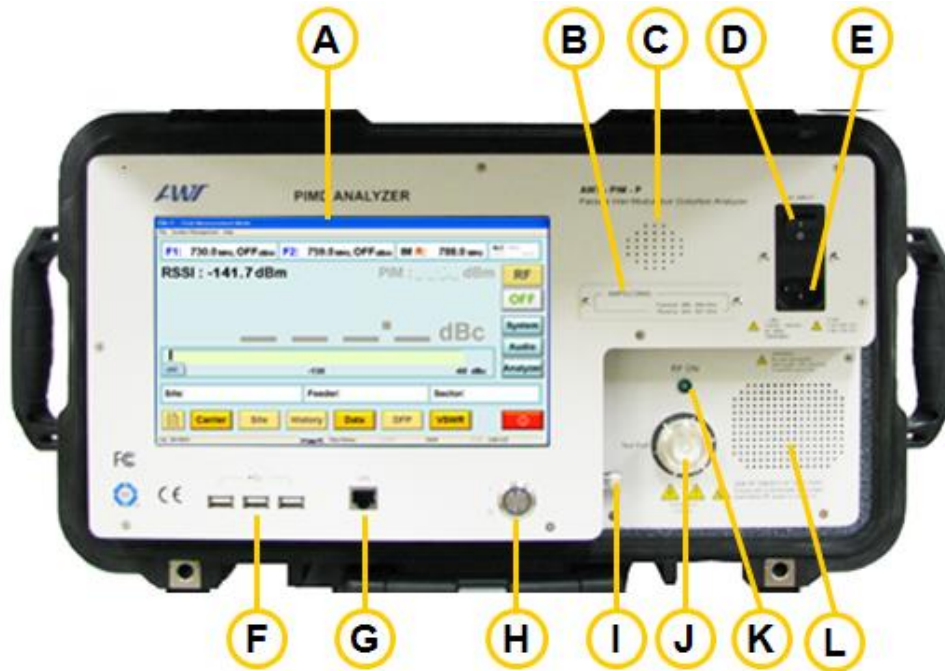


2. AWT PIM Analyzer Review



❖ Portable PIM Elements

● FRONT PANEL

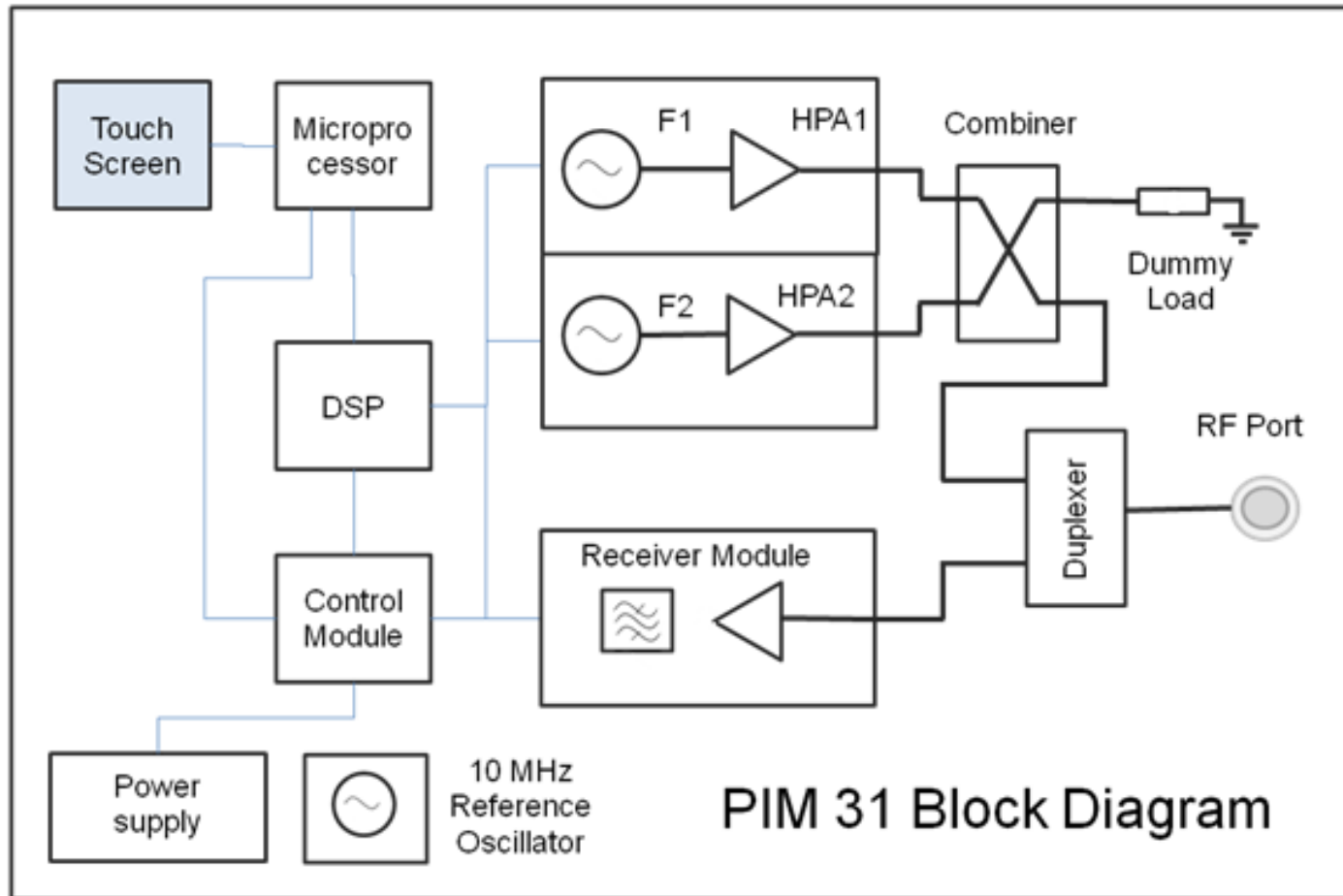


No.	Element
A	Touch Screen Display
B	Type Label
C	Audio
D	Main Power Switch
E	Main Power supply
F	USB Ports (3)
G	LAN connector
H	Power Switch
I	10 MHz Reference out
J	RF Port w
K	RF Power On
L	Front Panel Air Vents

2. AWT PIM Analyzer Review

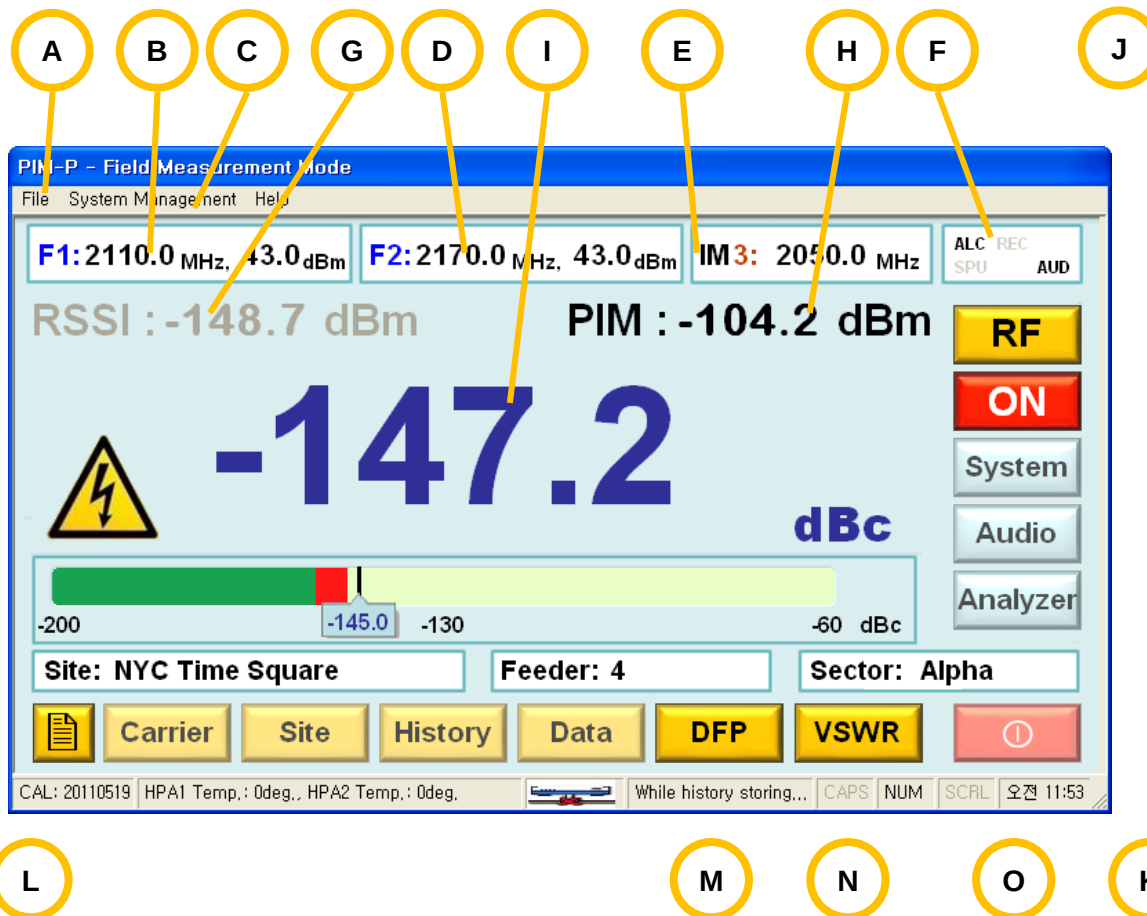


❖ Portable PIM Block Diagram



❖ Portable PIM Block Diagram

● FIELD MEASUREMENT MODE



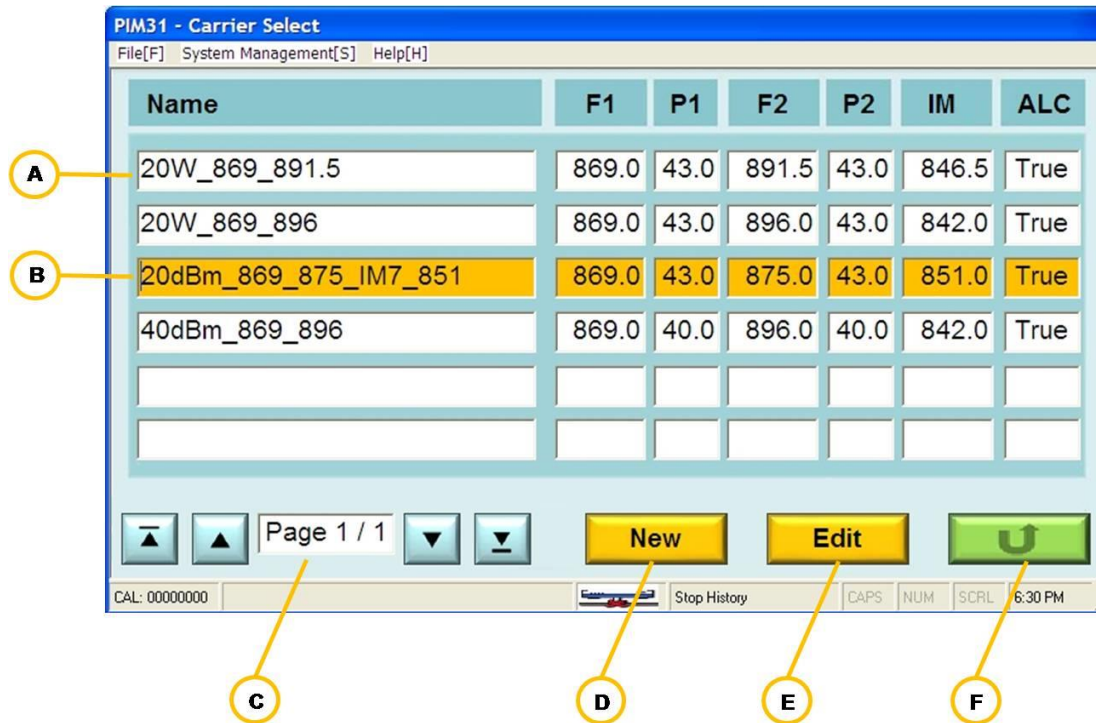
- A : File Menu
- B : Carrier Field (F1)
- C : System Management
- D : Carrier Field (F2)
- E : IM order
- F : ALC
- G : RSSI
- H : PIM Value [dBm]
- I : PIM Value [dBc]
- J : RF On/Off Switch
- K : Audio On/Off
- L : Record
- M : Distance to Faulty PIM
- N : VSWR Measure
- O : EXIT

2. AWT PIM Analyzer Review



❖ Portable PIM Program

- FIELD MEASUREMENT MODE : Carrier Select



A : Carrier

B : Selected Carrier

C : Page Indicator & Jump Arrow

D : New

E : Edit

F : Return

2. AWT PIM Analyzer Review



❖ Portable PIM Program

- FIELD MEASUREMENT MODE : Carrier Select : Carrier Edit

The screenshot shows the 'PIM31 - Carrier Select' window. It features a menu bar with 'File[F]', 'System Management[S]', and 'Help[H]'. The main area includes a 'Name' field with the text '20W_869_896'. Below this are two columns of frequency and power settings: F1 (869.0), P1 (43.0), F2 (896.0), and P2 (43.0). To the right is an 'IM3' section showing '842.0'. A numeric keypad is at the bottom, with an 'ENTER' key. Callouts A through L point to specific elements: A (Carrier 1 Parameters), B (Carrier Name), C (Carrier 2 Parameters), D (ALC), E (Return), F (IM), G (123/ABC), H (Delete), I (Enter), J (Keyboard), K (Space), and L (Capitals).

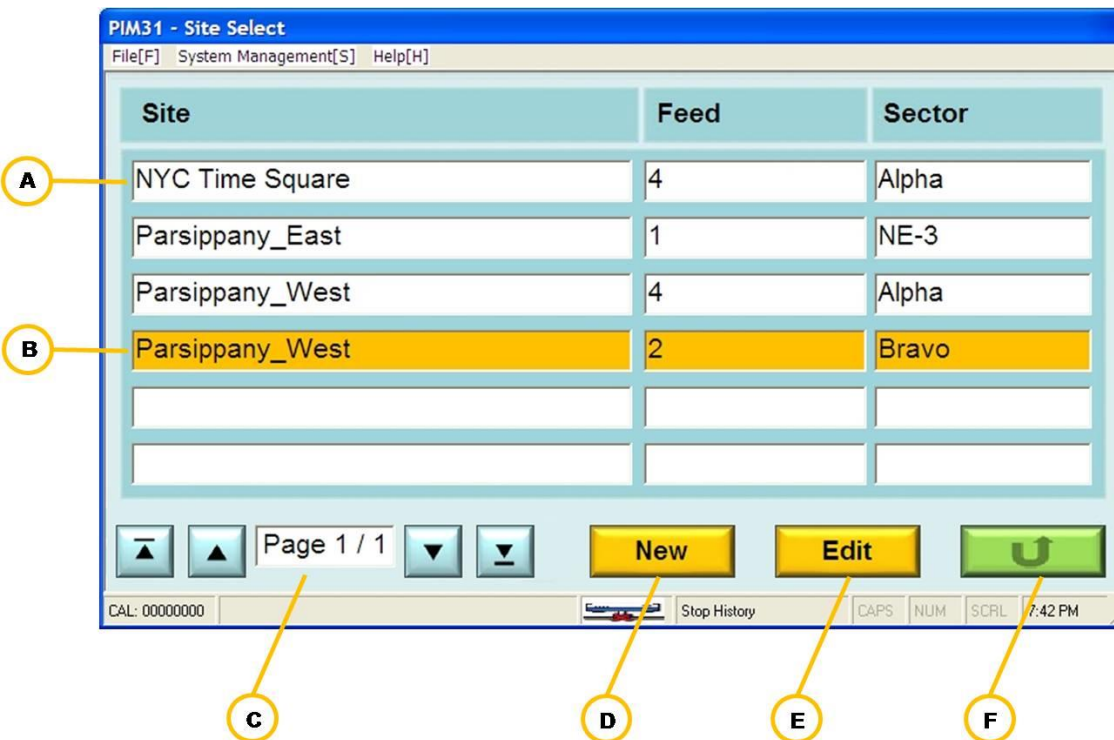
A : Carrier 1 Parameters
B : Carrier Name
C : Carrier 2 Parameters
D : ALC
E : Return
F : IM
G : 123/ABC
H : Delete
I : Enter
J : Keyboard
K : Space
L : Capitals

2. AWT PIM Analyzer Review



❖ Portable PIM Program

- FIELD MEASUREMENT MODE : Site Entry



- A : Site
- B : Selected Site
- C : Page Indicator & Jump Arrow
- D : New
- E : Edit
- F : Return

2. AWT PIM Analyzer Review



❖ Portable PIM Program

- FIELD MEASUREMENT MODE : Site Entry : Site Edit

The screenshot shows the 'PIM31 - Site Select' window. It features a menu bar with 'File[F]', 'System Management[S]', and 'Help[H]'. The main area contains several input fields and buttons. Callout letters A through M point to specific elements: A points to the 'Name' field (containing '20W_869_896'), B points to the 'Comment' button, C points to the 'Site' field (containing 'Princeton Main Street'), D points to the 'Sector' field (containing 'Alpha'), E points to a green 'Return' button with a circular arrow, F points to the 'Feed' field (containing '1'), G points to the 'User' field (containing 'J.Miller'), H points to a numeric keypad with '123', I points to a 'Delete' button with a left arrow, J points to an 'ENTER' button, K points to the 'V' key on a QWERTY keyboard, L points to the 'CAPS' button, and M points to the 'NUM' button. At the bottom, there is a status bar with 'CAL: 00000000', a 'Stop History' button, and a clock showing '7:56 PM'.

- A : Carrier Name
- B : Comment
- C : Site/Test Name
- D : Sector
- E : Return
- F : Feed
- G : User
- H : 123/ABC
- I : Delete
- J : Enter

2. AWT PIM Analyzer Review



❖ Portable PIM Program

- FIELD MEASUREMENT MODE : Site Entry : Site Edit : Comment

PIM 31 – Site Information - Comment

Name **Site Info** 

More Site Info

Q	W	E	R	T	Y	U	I	O	P	123
A	S	D	F	G	H	J	K	L	-	←
Z	X	C	V	B	N	M	.		↑	ENTER

2. AWT PIM Analyzer Review



❖ Portable PIM Program

● FIELD MEASUREMENT MODE : History Screen

PIM 31 – Site History

Site: NYC Penn Station **Feeder:** Alpha **Sector:** NW-3

YYYY MM DD	HH:MM:SS	PIM	Freq 1	Pwr 1	Freq 2	Pwr 2	RSSI	Future	Future
2009 08 22	23:15:54	-173.5	2222.0	43.0	2292.0	43.0	-123.5	Future	Future
2009 08 22	23:15:49	-172.8	2222.0	43.0	2292.0	43.0	-122.9	Future	Future
2009 08 22	23:15:44	-165.2	2222.0	43.0	2292.0	43.0	-103.5	Future	Future
2009 08 22	23:15:39	-173.4	2222.0	43.0	2292.0	43.0	-119.5	Future	Future
2009 08 21	16:29:13	-173.5	2222.0	43.0	2292.0	43.0	-118.4	Future	Future
2009 08 18	12:15:07	-174.7	2222.0	43.0	2292.0	43.0	-123.1	Future	Future
2009 08 17	09:47:32	-175.1	2222.0	43.0	2292.0	43.0	-116.2	Future	Future
2009 07 12	14:52:50	-176.2	2222.0	43.0	2292.0	43.0	-120.7	Future	Future
2009 06 14	07:20:33	-175.8	2222.0	43.0	2292.0	43.0	-122.9	Future	Future
2009 05 01	18:39:45	-176.9	2222.0	43.0	2292.0	43.0	-125.3	Future	Future

Page 12 / 395

▲ ▲ ▼ ▼ ↺

A : Site

B : Log Data Set

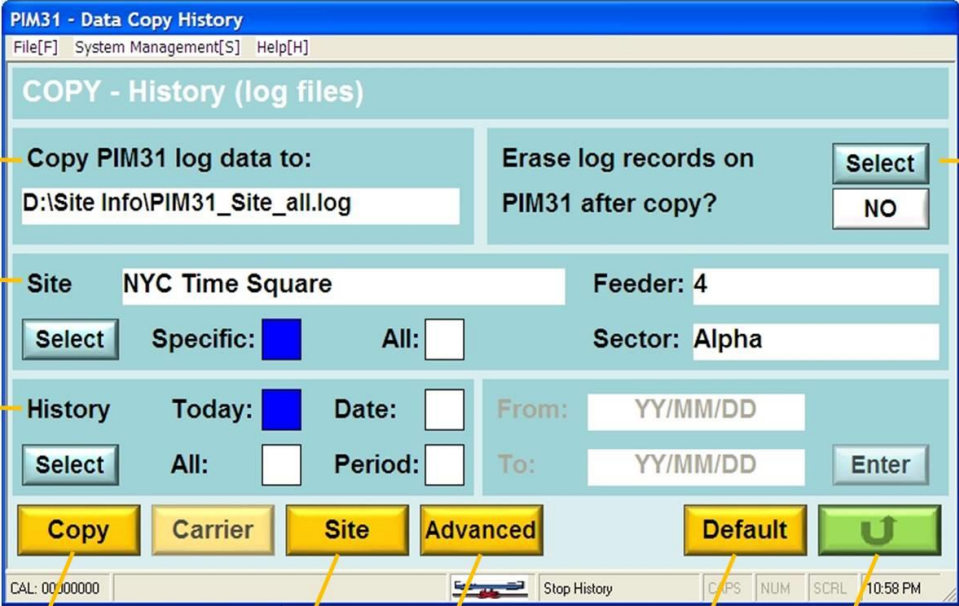
C : Selected Log Data Set

D : Page Indicator & Jump Arrows

E : Return

❖ Portable PIM Program

● FIELD MEASUREMENT MODE : Data : Data Copy



The screenshot shows the 'PIM31 - Data Copy History' dialog box. It has a menu bar with 'File[F]', 'System Management[S]', and 'Help[H]'. The main title is 'COPY - History (log files)'. The dialog is divided into several sections. The top section has two main areas: 'Copy PIM31 log data to:' with a text field containing 'D:\Site Info\PIM31_Site_all.log' (callout A) and 'Erase log records on PIM31 after copy?' with 'Select' and 'NO' buttons (callout B). Below this is the 'Site' section (callout C) with a text field 'NYC Time Square', a 'Feeder' field with value '4', and buttons 'Select', 'Specific:' (with a blue square), and 'All:' (with a white square). The 'Sector' field has the value 'Alpha'. The 'History' section (callout D) has a 'Today:' field with a blue square, a 'Date:' field, and buttons 'Select' and 'All:' (with a white square). It also has 'From:' and 'To:' date fields with 'YY/MM/DD' format and an 'Enter' button. At the bottom are five buttons: 'Copy' (callout E), 'Carrier', 'Site' (callout F), 'Advanced' (callout G), 'Default' (callout H), and a green button with a circular arrow (callout I). The status bar at the very bottom shows 'CAL: 00000000', a small icon, 'Stop History', and some other fields.

A : Copy Location

B : Erase Yes/No

C : Site Name

D : History

E : Copy

F : Site

G : Advanced

H : Default

I : Return

2. AWT PIM Analyzer Review



❖ Portable PIM Program

- FIELD MEASUREMENT MODE : Data : Data Delete Log Files

PIM31 - Data - Delete History

File[F] System Management[S] Help[H]

DELETE - History (log files) Selected log files will be erased!

A Carrier: 20W_869_896 F1 / F2: 869.0 896.0
Select None: ☐ Specific: ☒ All: ☐ P1 / P2: 43.0 43.0

B Site: NYC Time Square Feeder: 4
Select None: ☐ Specific: ☒ All: ☐ Sector: Alpha

C History: Today: ☐ Date: ☐ From: YY/MM/DD
Select All: ☒ Period: ☐ To: YY/MM/DD Enter

D Delete **E** Carrier **F** Site **G** Advanced **H** Default **I**

CAL: 00000000 Stop History CAPS NUM SCRL 11:29 PM

A : Carrier Display

B : Site Display

C : History

D : Delete

E : Carrier

F : Site

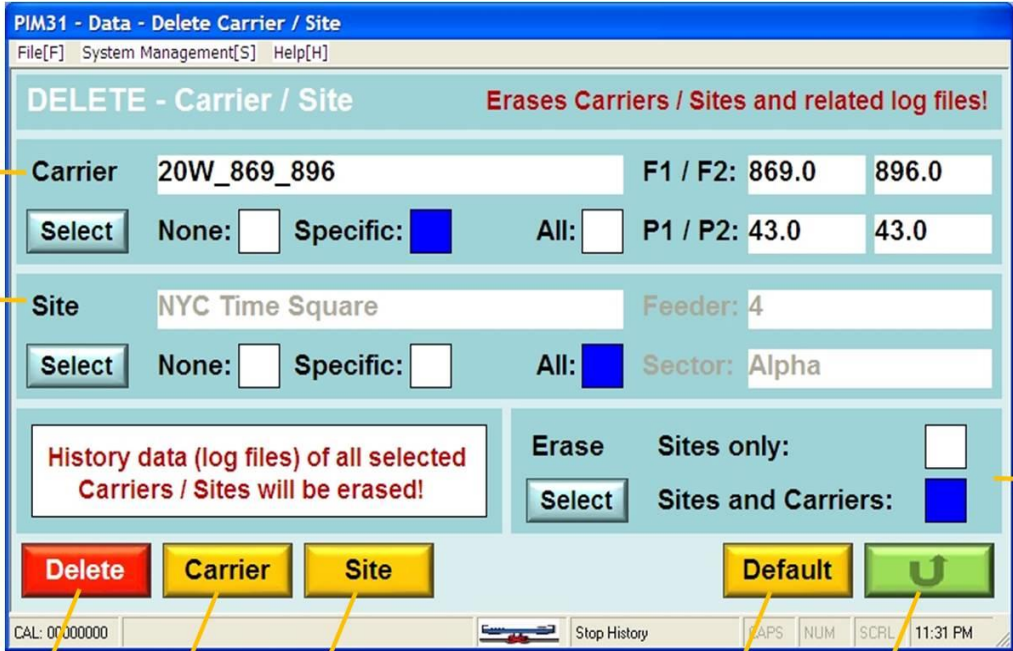
G : Advanced

H : Default

I : Return

❖ Portable PIM Program

- FIELD MEASUREMENT MODE : Data : Data Delete Carrier & Site



DELETE - Carrier / Site Erases Carriers / Sites and related log files!

A Carrier: 20W_869_896 F1 / F2: 869.0 896.0
Select None: ☐ Specific: ☒ All: ☐ P1 / P2: 43.0 43.0

B Site: NYC Time Square Feeder: 4
Select None: ☐ Specific: ☐ All: ☒ Sector: Alpha

History data (log files) of all selected Carriers / Sites will be erased!

Erase Sites only: ☐
Select Sites and Carriers: ☒ **C**

D Delete **E** Carrier **F** Site **G** Default **H** 

CAL: 00000000 Stop History CAPS NUM SCRL 11:31 PM

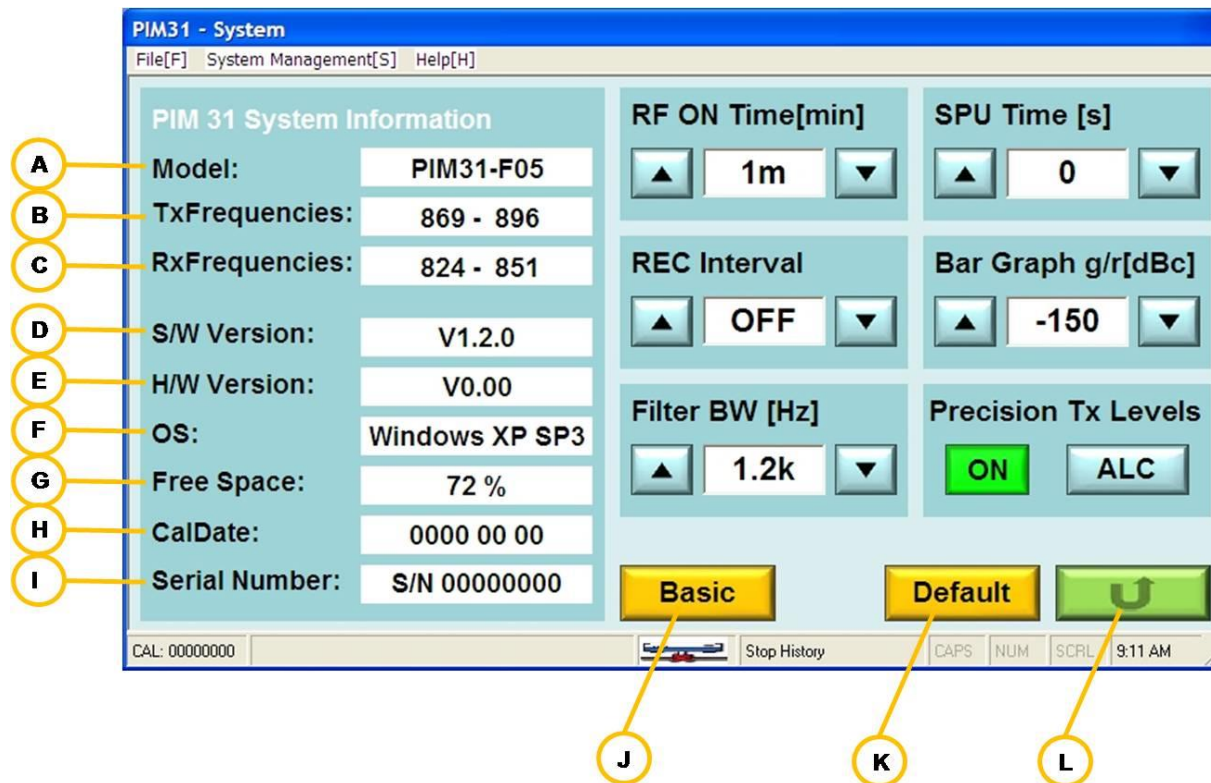
Legend:
A : Carrier Display
B : Site Display
C : Site Only Site & Carriers
D : Delete
E : Carrier
F : Site
G : Default
H : Return

2. AWT PIM Analyzer Review



❖ Portable PIM Program

● FIELD MEASUREMENT MODE : System Menu



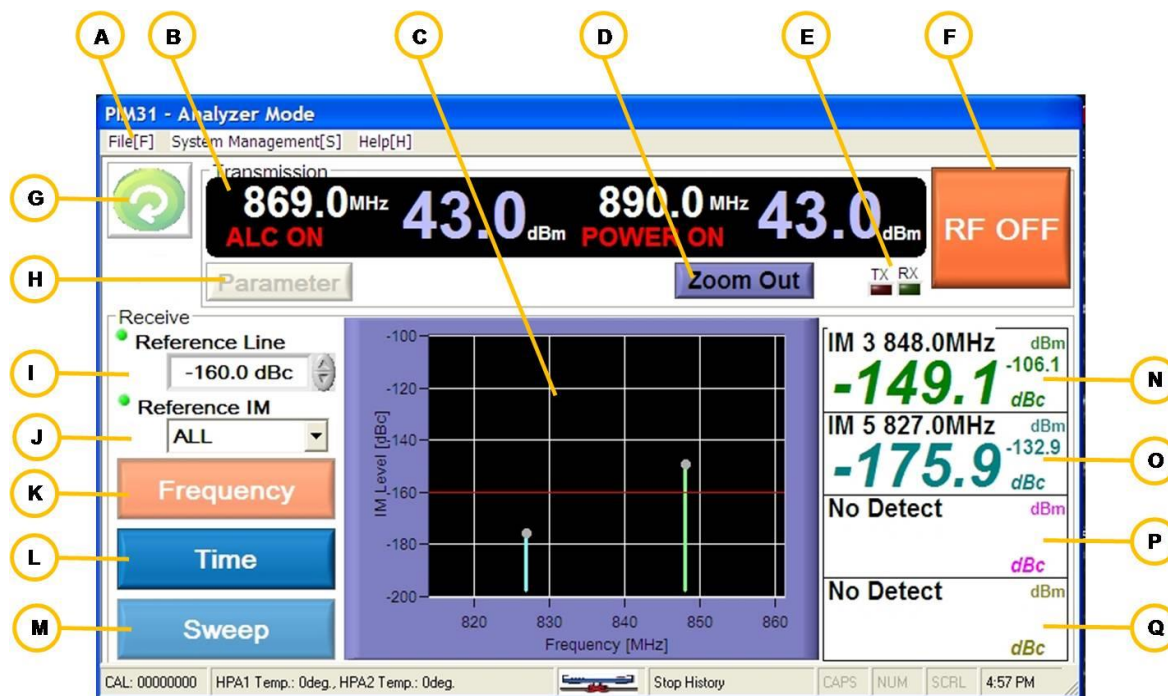
- A : Model
- B : TX Freq.
- C : RX Freq.
- D : SW Version
- E : HW Version
- F : Operation System
- G : Free Space
- H : Cal Data
- I : Serial Number
- J : Basic/Advanced
- K : Default
- L : Return

2. AWT PIM Analyzer Review



❖ Portable PIM Program

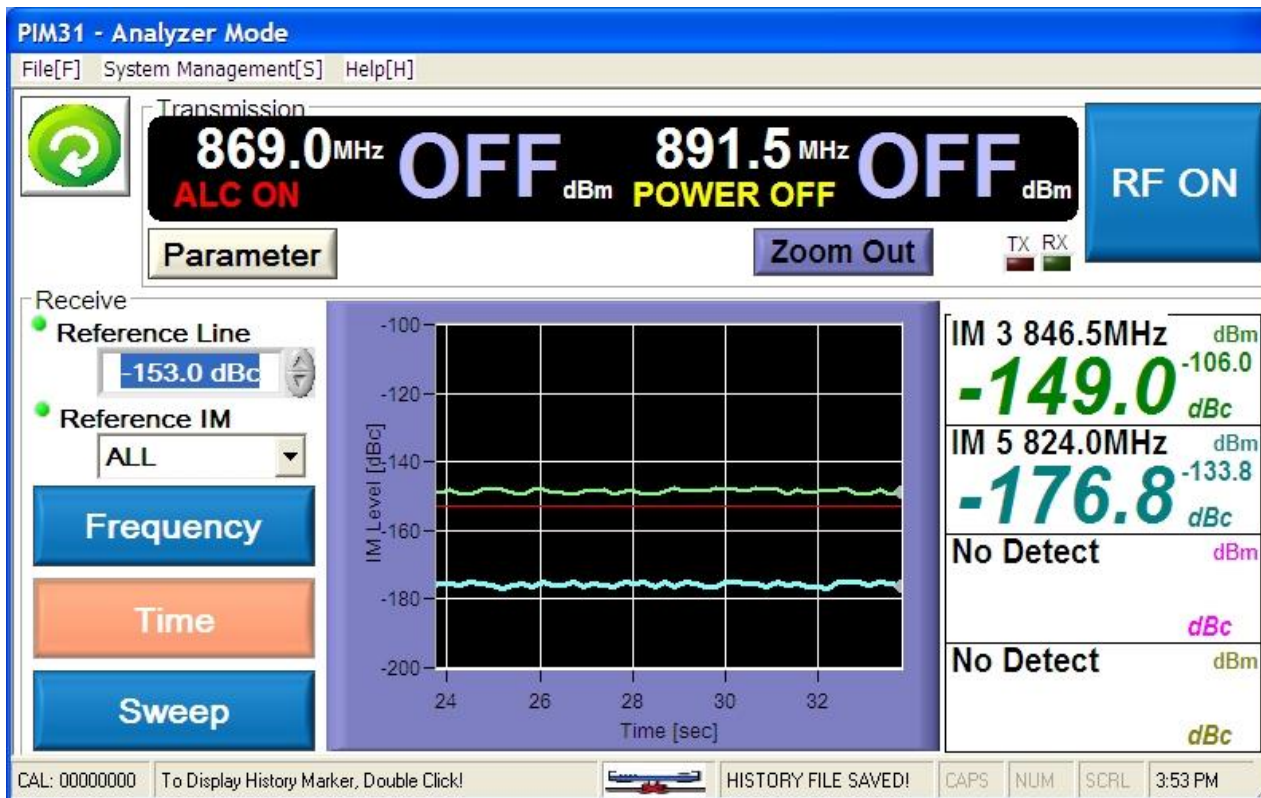
● Analyzer MODE : Frequency Mode



- A : Pull-Down Menu
- B : Carrier Display
- C : Graphical Display
- D : Zoom Out
- E : Tx/Rx
- F : RF Power Button
- G : Return
- H : Parameter Setting
- I : Reference Line
- J : Reference IM
- K : Frequency
- L : Time
- M : sweep
- N : Numeric Field 1
- O : Numeric Field 2
- P : Numeric Field 3
- Q : Numeric Field 4

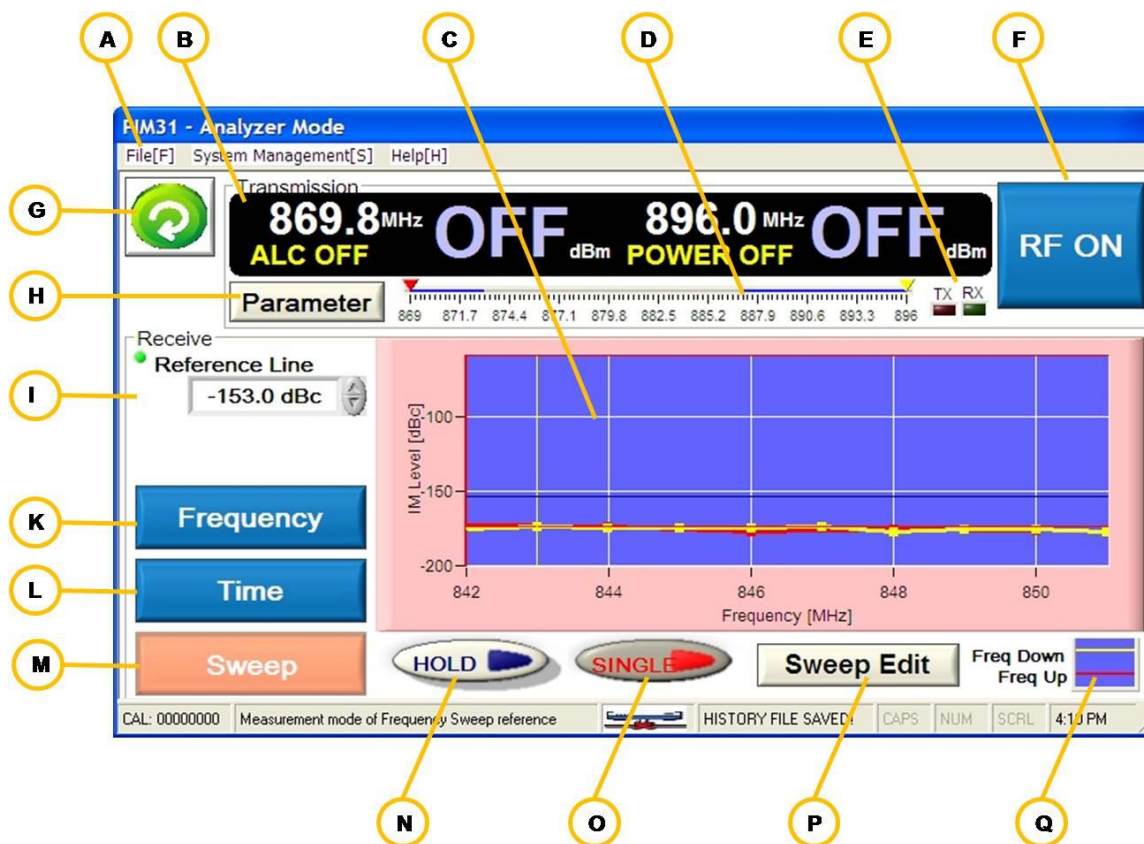
❖ Portable PIM Program

- Analyzer MODE : Time Mode



❖ Portable PIM Program

● Analyzer MODE : Sweep Mode



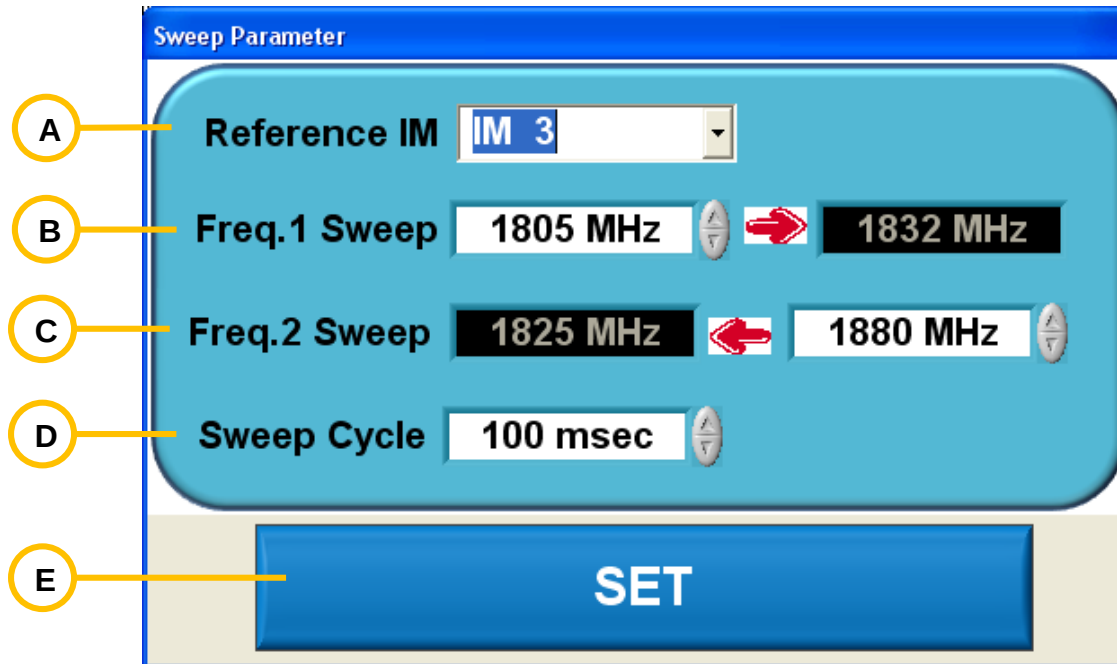
- A : Pull-Down Menu
- B : Carrier Display
- C : Graphical Display
- D : Tx Range
- E : Tx/Rx
- F : RF Power Button
- G : Return
- H : Parameter Setting
- I : Reference Line
- K : Frequency
- L : Time
- M : sweep
- N : Hold
- O : Single
- P : Sweep Edit
- Q : Freq Up/Down

2. AWT PIM Analyzer Review



❖ Portable PIM Program

- Analyzer MODE : Sweep Mode : Sweep Parameter



A : Reference IM

B : Freq 1 Sweep

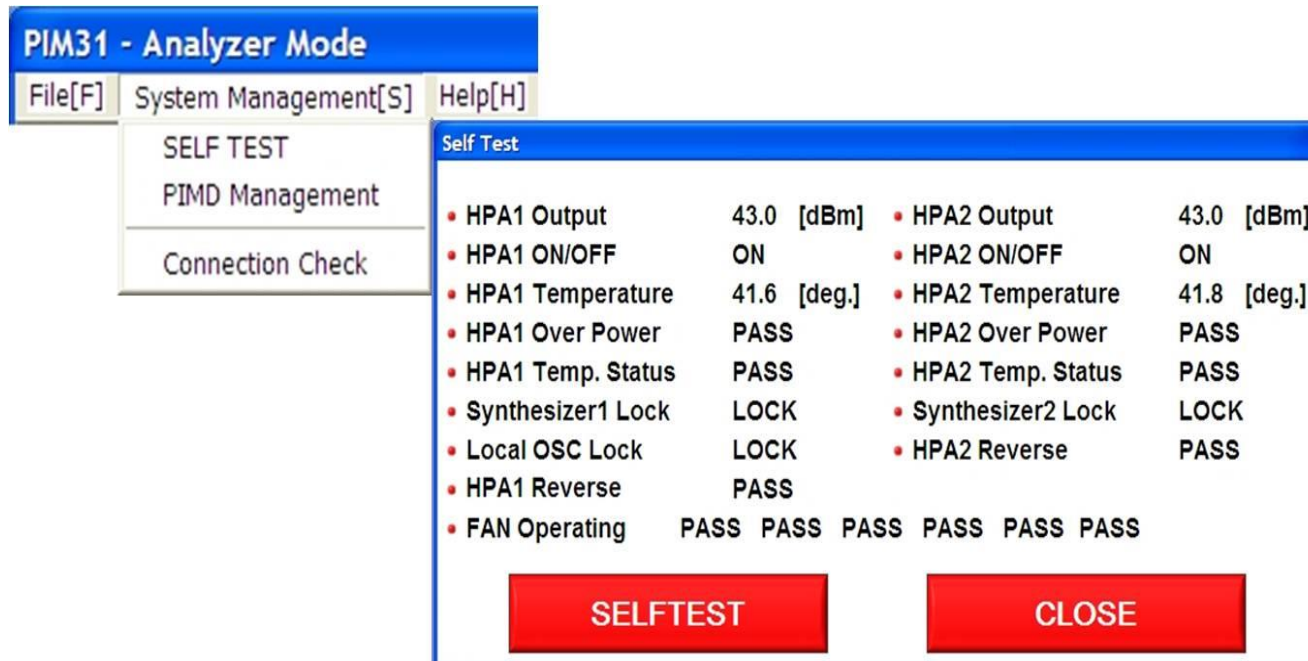
C : Freq 2 Sweep

D : Sweep Cycle

E : Set

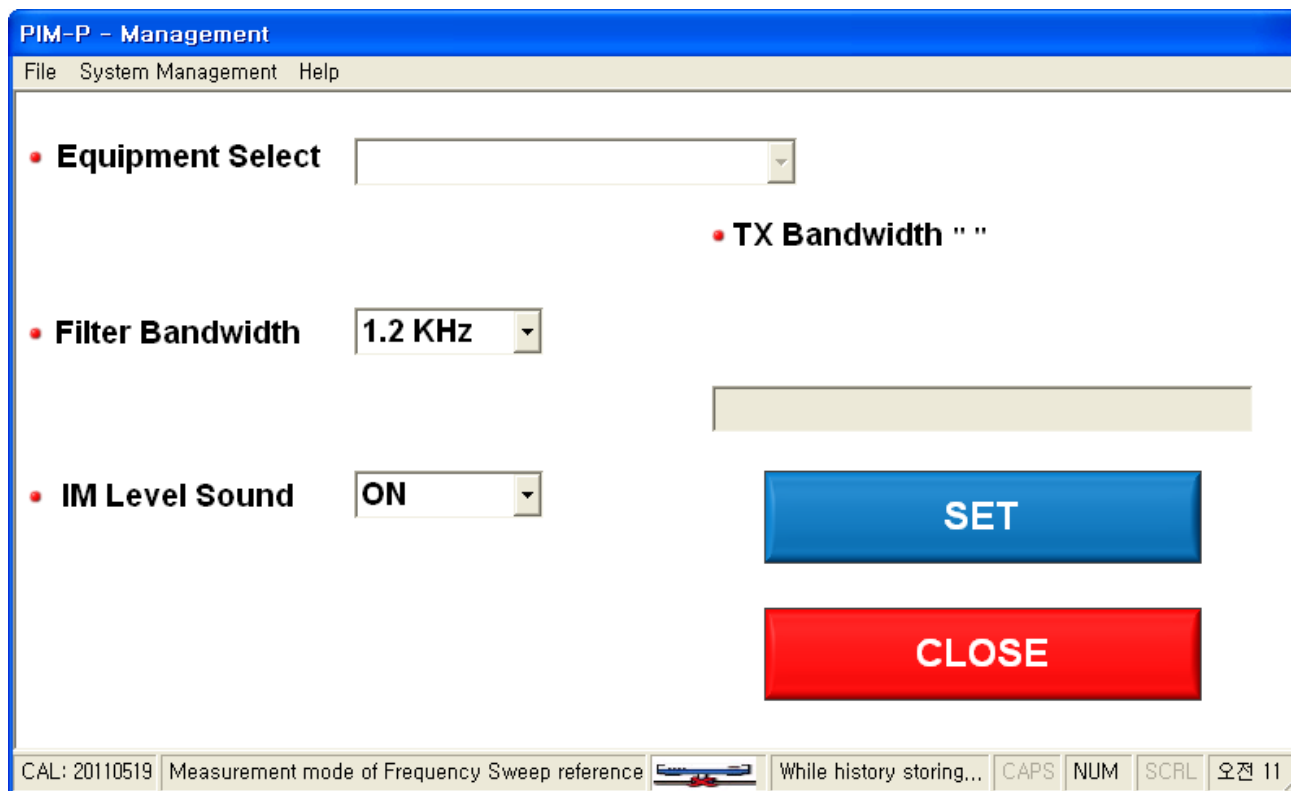
❖ Portable PIM Program

- Self Test



❖ Portable PIM Program

● PIM Management

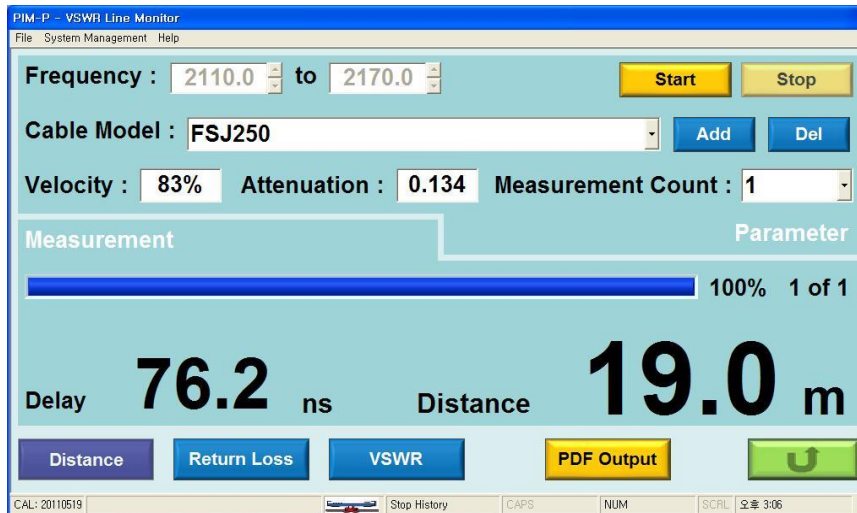


2. AWT PIM Analyzer Review



❖ Distance to Faulty PIM/ VSWR

- DFP (Distance to Faulty PIM)



3. AWT PIM Analyzer Specifications



❖ Portable PIM Types

Portable PIM	Tx Band	Rx Band	Technology
PIM2001	869-896 MHz	824-851 MHz	CDMA (850)
PIM2002	935-960 MHz	890-915 MHz	GSM (900)
PIM2003	925-960 MHz	880-915 MHz	EGSM (900)
PIM2004	1805-1880 MHz	1710-1785 MHz	DCS (1800)
PIM2005	1930-1990 MHz	1850-1910 MHz	PCS (1900)
PIM2006	2110-2170 MHz	1920-2060 MHz	UMTS/WCDMA (2100)
PIM2008	728-759 MHz	776-788 MHz	LTE (700-U)
PIM2009	728-759 MHz	698-716 MHz	LTE (700-L)

3. AWT PIM Analyzer Specifications



❖ Portable PIM Specifications

General specification	
Application usage	Field test and Lab test
Type	Portable (Built-in Case with wheels)
Common	
Power Supply	AC 100~240V, 50/60Hz
Power Consumption (VA)	665watt
Warm up Time (min.)	≤ 5 minutes
Internal Memory	RAM : 1G DDR2 533 SDRAM, HDD : 40G 2.5" SSD SATA2 MLC
USB	3 x USB
User Interface	
Monitor Display Size	10.2inch TFT Touch Screen
Touch Screen	support
Screen Capture	support
External Keyboard	support
External Monitoring	Optional
Automatic Test	support
Export Report format	.jpg, .xls , .pdf, .txt

3. AWT PIM Analyzer Specifications



❖ Portable PIM Specifications

Physical Specification	
Test port Connector Type	DIN female
USB	support
LAN	support
Frequency Reference	support
RGB	support
Dimension H x W x D (mm)	457 x 305 x 500(mm)
Weight (kg)	≤26kg (for DCS1800, IMT-E(2600), PCS1900, UMTS/WCDMA) ≤27kg (for AMPS/CDMA(850), GSM, LTE-U, LTE-L)
Environmental Specification	
Operating temperature (oC)	0- 50°C
Upper Bound Temperature	50°C
Relative humidity (%)	80%
Operating	IP20
Non-Operating	IP66

3. AWT PIM Analyzer Specifications



❖ Portable PIM Specifications

Electrical Specification	
Transmit Specification	
Method of 2 Frequencies Generation	Field Mode, Development Mode (Fixed Frequencies , Time Sweep, Frequency Sweep)
Frequency Accuracy (ppm)	± 2 ppm
Max. output power (dBm)	$\geq +44$ x 2-tones, option :+46dBm
Adjustable range (dB)	24(+20~+44dBm), option :+46dBm
Adjustable resolution (dB)	0.25
Power Accuracy (dB)	± 0.35
Test port Protection	+43dBm / in ≥ 5 sec
Receiver Specification	
IMD Order Measurement	3rd ,5th ,7th~27th
Residual PIM (dBm)	≤ -129 dBm (Typ. -172dBc)
Residual PIM Accuracy (dB)	± 0.35
Noise floor (dBm)	≤ -138 dBm at IF BW 300Hz ≤ -133 dBm at IF BW 1.2KHz
Max. IMD Level (dBm)	≥ -40 dBm
Dynamic Range (dB)	≥ 96 dB
Max. Damage Input power (dBm)	≥ -10 dBm

3. AWT PIM Analyzer Specifications



❖ Portable PIM Specifications

Option-Measure the Distance	
Need the other instruments	Portable 1 unit
Cable Type support	Support (User can modify)
Distance to Faulty PIM	
Distance Accuracy (m)	Typ. $\pm 0.5\text{m}$
Distance to Faulty VSWR	
Distance Accuracy (m)	$\pm 0.5\text{m}$
RL Range (dB)	$\leq 20\text{dB(Typical)}$

3. AWT PIM Analyzer Specifications



❖ Portable PIM Specifications

Portable PIM Accessories	
Accessories Bag	1 unit : Portable (Built-in Case with wheels)
Low PIM Load	1 unit : 100w, PIM < -168 dBc, 7/16(F)
Low PIM Adapter 7/16 (f) to N (m)	1 unit
Low PIM Adapter 7/16 (f) to N (f)	1 unit
Low PIM Adapter 7/16 (m) to N (m)	Optional
Low PIM Adapter 7/16 (m) to N (f)	Optional
Low PIM Adapter 7/16 DIN (f) to 7/16 DIN (f)	1 unit
Low PIM Adapter 7/16 DIN (m) to 7/16 DIN (m)	Optional
Low PIM Adapter 7/16 DIN (m) to 7/16 DIN (f)	Optional
Low PIM Cable	3 unit : 7/16(m)-7/16(m)3/8"Jumper 1m (or 3m) 7/16(m)-N(m) 3/8"Jumper 1m 7/16(m)-N(m) 3/8"Jumper 3m
Wrench	1 : 32 mm. Torque Wrench (10-50 N.m.) Optional : 19 mm. Torque Wrench (1-20 N.m.)
PIM Source	Optional
Mouse	Optional
Keyboard	Optional
Optical Cleaning Set	1 set

3. AWT PIM Analyzer Specifications



❖ Portable PIM Shapes



❖ Portable PIM Accessories



❖ Distance to Faulty PIM/ VSWR

	Pros.	Cons.
PIM TEST	- PIM TEST is carried to measure the PIM values of passive component (e.g. connectors, cables, adapters, and etc.) in the base stations or repeater systems. - It is easy to identify any loose connections between cables or adapters in the RF path. - With periodic PIM test, you can keep your network systems being good condition.	- It will not be used as criteria to decide any defective cables or junctions by PIM test results only. - To be in the safe side, it is highly recommended the VSWR and PIM test together.

❖ Distance to Faulty PIM/ VSWR

	Pros.	Cons.
VSWR TEST	- VSWR TEST is carried to check the return loss of RF components (connectors, cables, adapters, and etc.) in base stations or repeaters. - Easy to measure electrical Characteristics of entire RF path. - It is Identified extremely damaged (e.g. open and short) cables or connectors on the RF path - Save the time and cost to repair by finding out the faulty VSWR location in RF path.	- It is not able to detect any potential problems caused by high power signals. - QoS (Quality of Service) would not be improved because it is not possible to detect the interference problems in the entire network system using VSWR test only.

❖ Distance to Faulty PIM/ VSWR

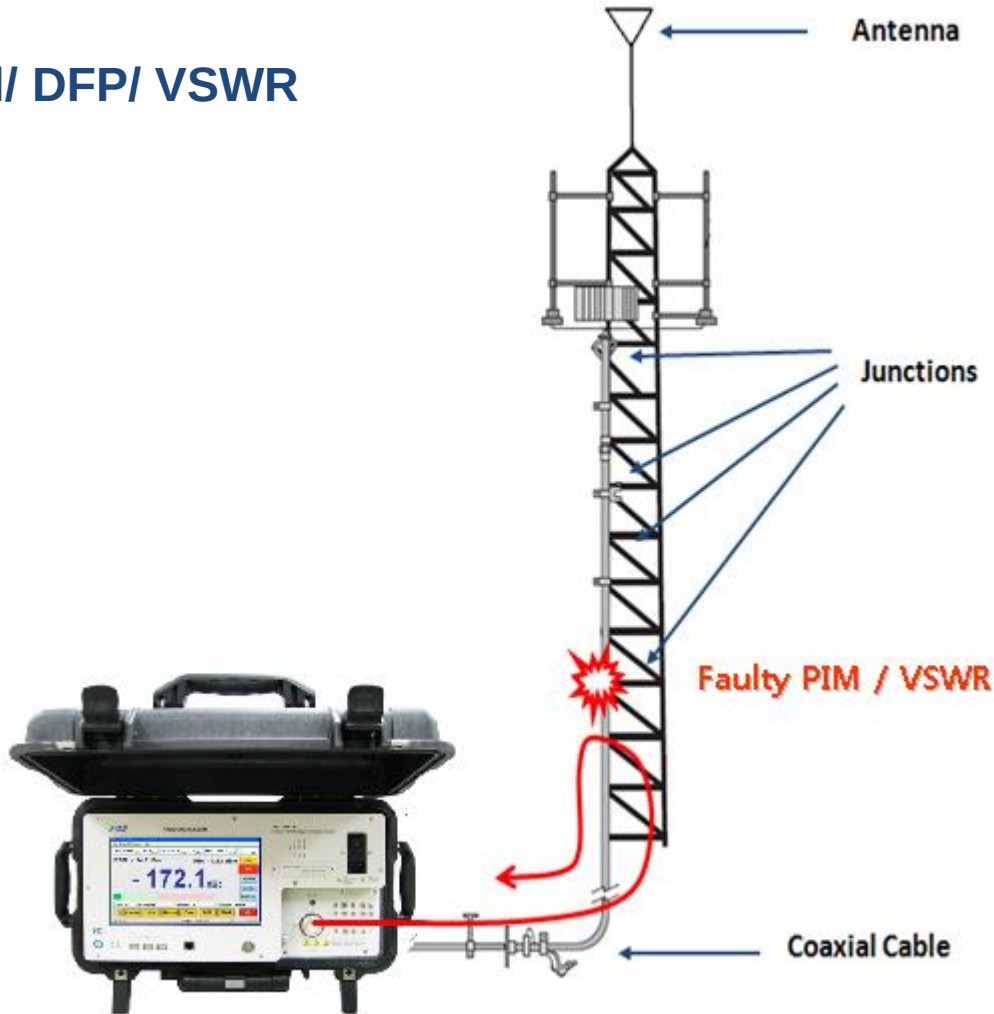
	Merits
PIM / VSWR TEST	▪ <u>AWT PIM Analyzer</u> include <u>VSWR TEST & PIM TEST</u> pros. ▪ Only using AWT's PIM Analyzer, it is possible to measure VSWR with high power condition, up to 20watts, which is more appropriate to <u>real sites</u>. (VSWR may depend on the Power level in some real fields) ▪ AWT's PIM Analyzer detects exactly the faulty VSWR and PIM location with <u>very high accuracy(±50cm)</u>. ▪ Using AWT's , you can <u>save the cost</u> and time for the maintenance of your network systems. ▪ With AWT's, there is no need to carry the other instruments such as Spectrum Analyzer, Network Analyzer or Site Master additionally.

4. AWT PIM Analyzer characteristics



❖ Measure the Base station/ Repeater

➤ PIM Level/ DFP/ VSWR



4. AWT PIM Analyzer characteristics



❖ How to AWT PIM Analyzer

Acceptance test

- Test the PIM Level for each passive component ex.) Cables, Connectors, Filters, Antennas etc.

Installation

- Discriminate the faulty or poor PIM components
- Measure PIM level of RF path in base stations or repeater systems.

Maintenance

- Detect and discriminate the faulty or poor PIM components which have put in the network systems already during installation.
- Recommended the periodic checks per 3~6months. Because the degradation of PIM values might be caused in accordance with aging, vibration, temperature and moisture

