PIR361 Portable ILS/VOR Receiver

Operating manual.

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Overview.

PIR361 is a field measurement receiver for LOC, GS, VOR and MB.
PIR361 is world's smallest and fastest data process speed Portable ILS Receiver as the year of 2016.
PIR361 is installed with a SBAS (Satellite Based Argumentation System) GPS receive inside.
Each of measurement parameters and tolerances are fully compliant with ICAO Annex 10.
Measurement report file will be saved as in excel file format with a laptop (windows 7_ 32bit excel).
IoT (Internet of Things) function is possible with a laptop CDMA GSM or PSTN connected.

LOC: Localizer GS: Glideslope VOR: VHF Omni-directional Radio MB: Marker beacon

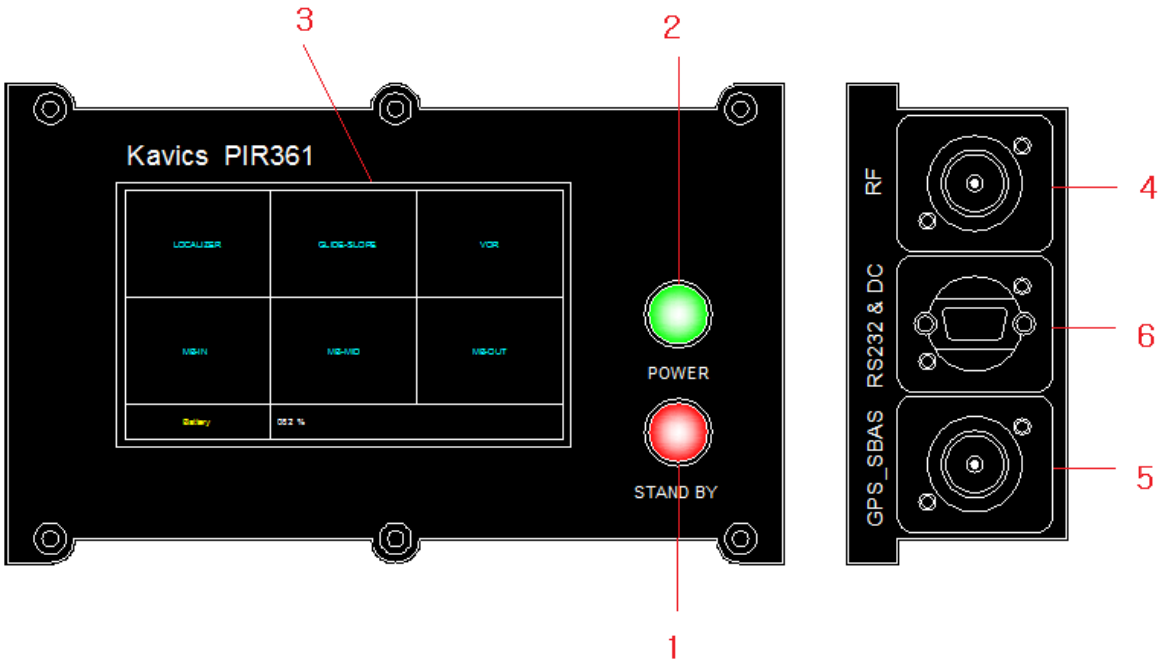
Specifications.

Electrical specifications			
Signals	LLZ/VOR	GS	MB
Frequency range	108~117.95MHz	329.15~335.0MHz	75MHz only
RF impedance	50Ω		
Rx sensitivity	-80~0dBm	-100dBm~-20dBm(External LNA)	
Frequency stability	±100ppb@+25°C		
RF power reading accuracy	±1dB		
ILS DDM accuracy	±0.0001		
VOR bearing angle accuracy	±0.1°		
Operating temperature	0°C ~+55°C		
Battery	5000mA/hour Li-ion (2hours operation after fully charged)		
AC power	110Vac or 220Vac via external AC-DC adapter		
Power consumption	4watts max with full brightness touch screen TFT LCD.		
GPS	SBAS GPS (±1meter long, lat /±2meter alt. accuracy with MSAS)		
LCD	5 Inch TFT resistive touch (480 X 272 pixel)		

Mechanical specifications	
Dimensions	196mm X 120mm X67mm (W x D x H)
Weight	1.8 kg
Body material	3mm thick aluminum.(EMI shield)
Waterproof	IP67

Table 1 Specifications

How to use PIR361.



Front view & side view of PIR361. (Figure 1)

No	Functional description
1	Main power stand by. (For 30sec stand by LED on after POWER off)
2	Power on/off toggle switch.
3	Touch screen LCD for each of measurement mode.
4	BNC RF signal input. +5Vdc comes out for external LNA !
5	BNC SBAS GPS antenna input. +3.3Vdc comes out for active GPS antenna !
6	9pin D sub RS232 data in output & +5Vdc for battery charge.

Table 2 Functional description

1. Press STAND BY.
2. Press POWER.
3. You will hear 1kHz beep tone sound after 12sec and main menu will be pop up as following.
4. Connect RF cable for antenna or transmitter monitor port.
   DC block should be put for any other devices except Kavics provided.
5. Connect active GPS antenna.
6. Connect RS232 data cable provided by Kavics.
   Connect serial to USB.
   Run air11 program(win7_32bit) provided by Kavics.

Localizer measurement.

LOCALIZER	GLIDE-SLOPE	VOR
MB-IN	MB-MID	MB-OUT
Battery	082 %	

Main menu. (Figure 2)

Press LOCALIZER area on LCD panel and Touch LCD screen will be pop up localizer measurement mode (Figure 3).

		LOCALIZER (Ch.001)	108.10 MHz	
RF - offset	-04.00 kHz	1020Hz-Freq	0000 Hz	
RF - PWR	-80.0 dBm	1020Hz-AM	00.0 %	
SDM	40.00 %	1 DDM Unit	(150Hz-90Hz) DDM Polarity	
DDM	-0.0000			
90Hz - Freq	90.0 Hz	0000.00000 N	00000.00000 E	
150Hz - Freq	150.0 Hz	0000.0 m	00:00.00 UTC	
Audio Phase	00.0 deg	+25.0 Celsius		
		CHANNEL SELECT	ON MUTE	Esc
Battery	072 %			

Localizer measurement mode. (Figure 3)

Press ON MUTE (sky blue color) you can listen to 1020Hz Morse code ID.
If you want to change DDM unit or polarity press DDM Unit, DDM Polarity (sky blue color).
Pressing Esc (sky blue color) will lead LCD screen back to main menu (Figure 2).
Press CHANNEL SELECT area and Touch LCD screen will be pop localizer channel select mode (Figure 4).

Localizer channel select mode. (Figure 4)

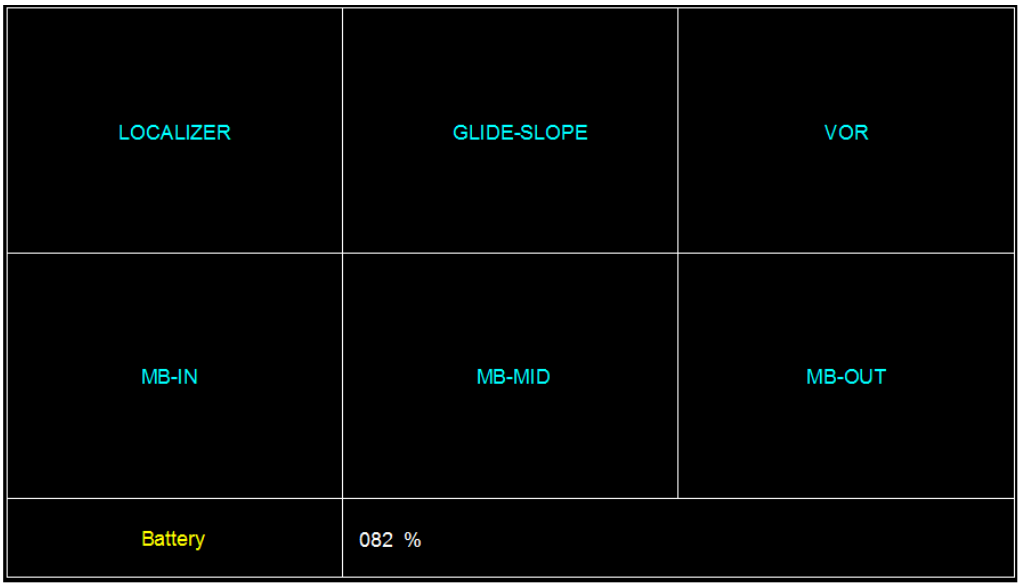
You can choose the channel with Table 3 Localizer channel select table below.

Press 0 0 1 (sky blue color) CH Number and press Enter (green color) then LCD will show up 012(yellow color) and LCD screen will go back to Localizer measurement mode (Figure 3).
If you want to change 3 digit of channel number, Press Esc (yellow color) and last digit number will be erased in sequences. Any channel number beyond between 001 and 040 is blocked out.

CH Number	Localizer Frequency (MHz)	CH Number	Localizer Frequency (MHz)
001	108.10000	**021**	110.10000
002	108.15000	**022**	110.15000
003	108.30000	**023**	110.30000
004	108.35000	**024**	110.35000
005	108.50000	**025**	110.50000
006	108.55000	**026**	110.55000
007	108.70000	**027**	110.70000
008	108.75000	**028**	110.75000
009	108.90000	**029**	110.90000
010	108.95000	**030**	110.95000
011	109.10000	**031**	111.10000
012	109.15000	**032**	111.15000
013	109.30000	**033**	111.30000
014	109.35000	**034**	111.35000
015	109.50000	**035**	111.50000
016	109.55000	**036**	111.55000
017	109.70000	**037**	111.70000
018	109.75000	**038**	111.75000
019	109.90000	**039**	111.90000
020	109.95000	**040**	111.95000

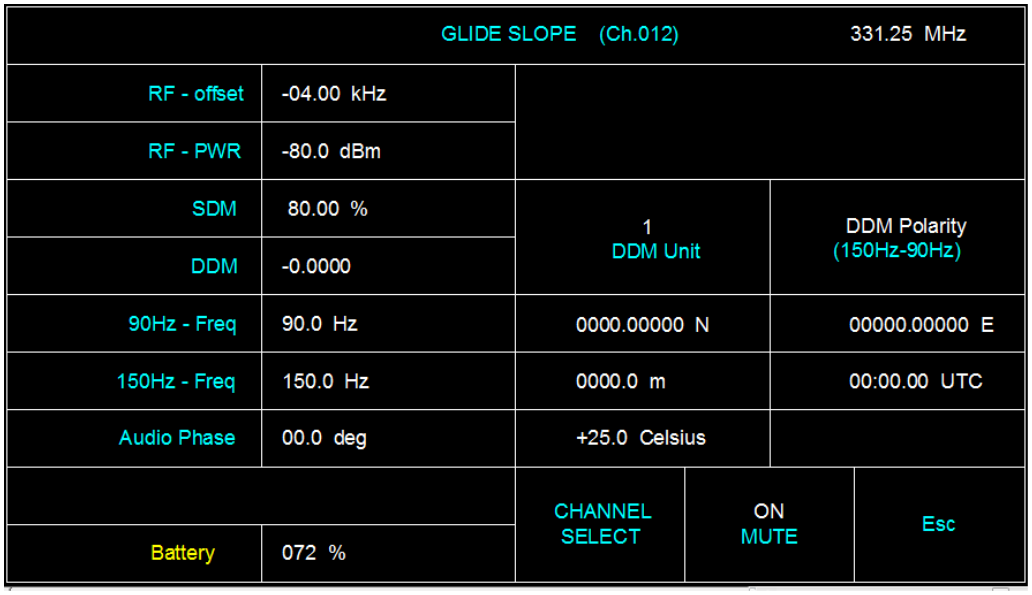
Table 3 Localizer channel select table.

Glideslope measurement.



Main menu. (Figure 5)

Press GLIDE-SLOPE area on LCD panel and Touch LCD screen will be pop up Glideslope measurement mode (Figure 6).



Glideslope measurement mode. (Figure 6)

If you want to change DDM unit or polarity press DDM Unit, DDM Polarity (sky blue color).
Pressing Esc (sky blue color) will lead LCD screen back to main menu (Figure 5).
Press CHANNEL SELECT area and Touch LCD screen will be pop glideslope channel select mode (Figure 7).

Glideslope channel select mode. (Figure 7)

You can choose the channel with Table 4 Glideslope channel select table below.

Press 0 1 2 (sky blue color) CH Number and press Enter (green color) then LCD will show up 012(yellow color) and LCD screen will go back to Glideslope measurement mode (Figure 6). If you want to change 3 digit of channel number, Press Esc (yellow color) and last digit number will be erased in sequences. Any channel number beyond between 001 and 040 is blocked out.

CH Number	Glideslope Frequency (MHz)	CH Number	Glideslope Frequency (MHz)
001	334.70000	**021**	334.40000
002	334.55000	**022**	334.25000
003	334.10000	**023**	335.00000
004	333.95000	**024**	334.85000
005	329.90000	**025**	329.60000
006	329.75000	**026**	329.45000
007	330.50000	**027**	330.20000
008	330.35000	**028**	330.05000
009	329.30000	**029**	330.80000
010	329.15000	**030**	330.65000
011	331.40000	**031**	331.70000
012	331.25000	**032**	331.55000
013	332.00000	**033**	332.30000
014	331.85000	**034**	332.15000
015	332.60000	**035**	332.90000
016	332.45000	**036**	332.75000
017	333.20000	**037**	333.50000
018	333.05000	**038**	333.35000
019	333.80000	**039**	331.10000
020	333.65000	**040**	330.95000

Table 4 Glideslope channel select table.

VOR measurement.

LOCALIZER	GLIDE-SLOPE	VOR
MB-IN	MB-MID	MB-OUT
Battery	082 %	

Main menu. (Figure 8)

Press VOR area on LCD panel and Touch LCD screen will be pop up VOR measurement mode (Figure 9).

		VOR (Ch.103)	115.10 MHz	
RF - offset	-04.00 kHz	9960Hz-AM	30.0 %	
RF - PWR	-80.0 dBm	FM-Index	16.0	
Bearing Angle	000.0 deg	1020Hz-Freq	1020 Hz	
30Hz-Freq	30.0 Hz	1020Hz-AM	10.0 %	
30Hz-AM	30.0 %	0000.00000 N	00000.00000 E	
9960Hz - Freq	09960.0 Hz	0000.0 m	00:00.00 UTC	
9960Hz-Dev	480.0 Hz	+25.0 Celsius		
FM-Rate	30.0 Hz	CHANNEL SELECT	ON MUTE	Esc
Battery	072 %			

VOR measurement mode. (Figure 9)

Press ON MUTE (sky blue color) you can listen to 1020Hz Morse code ID.
Pressing Esc (sky blue color) will lead LCD screen back to main menu (Figure 8).
Press CHANNEL SELECT area and Touch LCD screen will be pop glideslope channel select mode (Figure 10).

VOR channel select mode. (Figure 10)

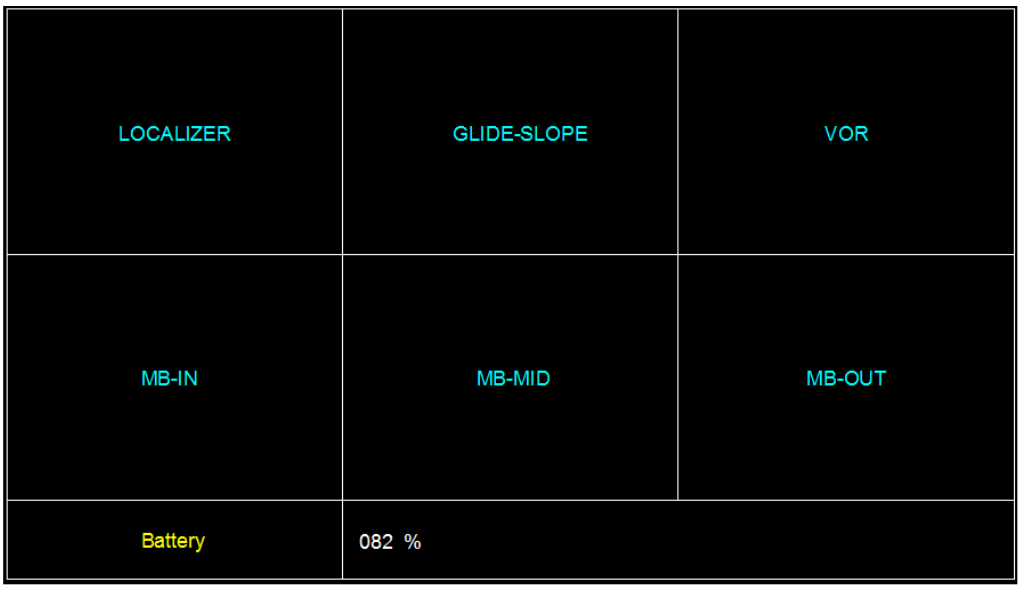
You can choose the channel with Table VOR channel select table below.

Press 1 0 3 (sky blue color) CH Number and press Enter (green color) then LCD will show up 012(yellow color) and LCD screen will go back to VOR measurement mode (Figure 8).
If you want to change 3 digit of channel number, Press Esc (yellow color) and last digit number will be erased in sequences. Any channel number beyond between 001 and 160 is blocked out.

CH Number	VOR Frequency (MHz)	CH Number	VOR Frequency (MHz)	CH Number	VOR Frequency (MHz)	CH Number	VOR Frequency (MHz)
001	108.00000	**041**	112.00000	**081**	114.00000	**121**	116.00000
002	108.05000	**042**	112.05000	**082**	114.05000	**122**	116.05000
003	108.20000	**043**	112.10000	**083**	114.10000	**123**	116.10000
004	108.25000	**044**	112.15000	**084**	114.15000	**124**	116.15000
005	108.40000	**045**	112.20000	**085**	114.20000	**125**	116.20000
006	108.45000	**046**	112.25000	**086**	114.25000	**126**	116.25000
007	108.60000	**047**	112.30000	**087**	114.30000	**127**	116.30000
008	108.65000	**048**	112.35000	**088**	114.35000	**128**	116.35000
009	108.80000	**049**	112.40000	**089**	114.40000	**129**	116.40000
010	108.85000	**050**	112.45000	**090**	114.45000	**130**	116.45000
011	109.00000	**051**	112.50000	**091**	114.50000	**131**	116.50000
012	109.05000	**052**	112.55000	**092**	114.55000	**132**	116.55000
013	109.20000	**053**	112.60000	**093**	114.60000	**133**	116.60000
014	109.25000	**054**	112.65000	**094**	114.65000	**134**	116.65000
015	109.40000	**055**	112.70000	**095**	114.70000	**135**	116.70000
016	109.45000	**056**	112.75000	**096**	114.75000	**136**	116.75000
017	109.60000	**057**	112.80000	**097**	114.80000	**137**	116.80000
018	109.65000	**058**	112.85000	**098**	114.85000	**138**	116.85000
019	109.80000	**059**	112.90000	**099**	114.90000	**139**	116.90000
020	109.85000	**060**	112.95000	**100**	114.95000	**140**	116.95000
021	110.00000	**061**	113.00000	**101**	115.00000	**141**	117.00000
022	110.05000	**062**	113.05000	**102**	115.05000	**142**	117.05000
023	110.20000	**063**	113.10000	**103**	115.10000	**143**	117.10000
024	110.25000	**064**	113.15000	**104**	115.15000	**144**	117.15000
025	110.40000	**065**	113.20000	**105**	115.20000	**145**	117.20000
026	110.45000	**066**	113.25000	**106**	115.25000	**146**	117.25000
027	110.60000	**067**	113.30000	**107**	115.30000	**147**	117.30000
028	110.65000	**068**	113.35000	**108**	115.35000	**148**	117.35000
029	110.80000	**069**	113.40000	**109**	115.40000	**149**	117.40000
030	110.85000	**070**	113.45000	**110**	115.45000	**150**	117.45000
031	111.00000	**071**	113.50000	**111**	115.50000	**151**	117.50000
032	111.05000	**072**	113.55000	**112**	115.55000	**152**	117.55000
033	111.20000	**073**	113.60000	**113**	115.60000	**153**	117.60000
034	111.25000	**074**	113.65000	**114**	115.65000	**154**	117.65000
035	111.40000	**075**	113.70000	**115**	115.70000	**155**	117.70000
036	111.45000	**076**	113.75000	**116**	115.75000	**156**	117.75000
037	111.60000	**077**	113.80000	**117**	115.80000	**157**	117.80000
038	111.65000	**078**	113.85000	**118**	115.85000	**158**	117.85000
039	111.80000	**079**	113.90000	**119**	115.90000	**159**	117.90000
040	111.85000	**080**	113.95000	**120**	115.95000	**160**	117.95000

Table 5 VOR channel select table.

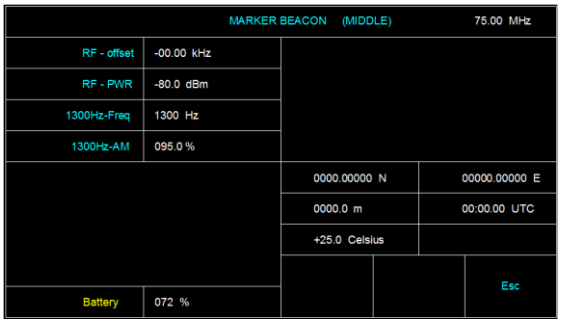
Marker beacon measurement.



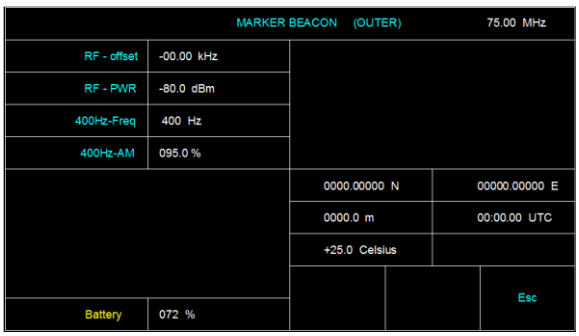
Main menu. (Figure 11)

Press MB-IN area on LCD panel and Touch LCD screen will be pop up inner marker beacon measurement mode (Figure 12).
Press MB-MID area on LCD panel and Touch LCD screen will be pop up middle marker beacon measurement mode (Figure 13).
Press MB-OUT area on LCD panel and Touch LCD screen will be pop up outer marker beacon measurement mode (Figure 14).

MB-IN measurement mode. (Figure 12)



MB-MID measurement mode. (Figure 13)

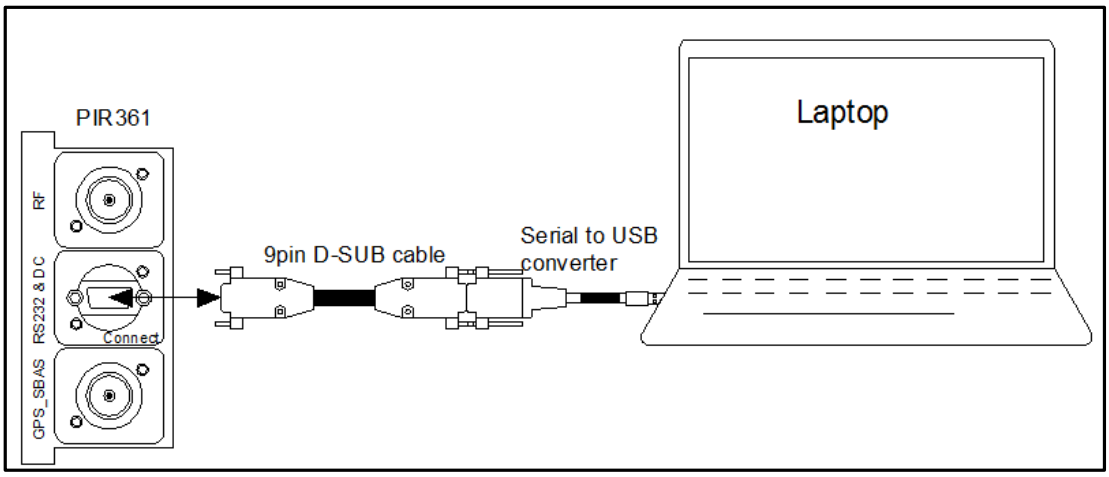


MB-OUT measurement mode. (Figure 14)

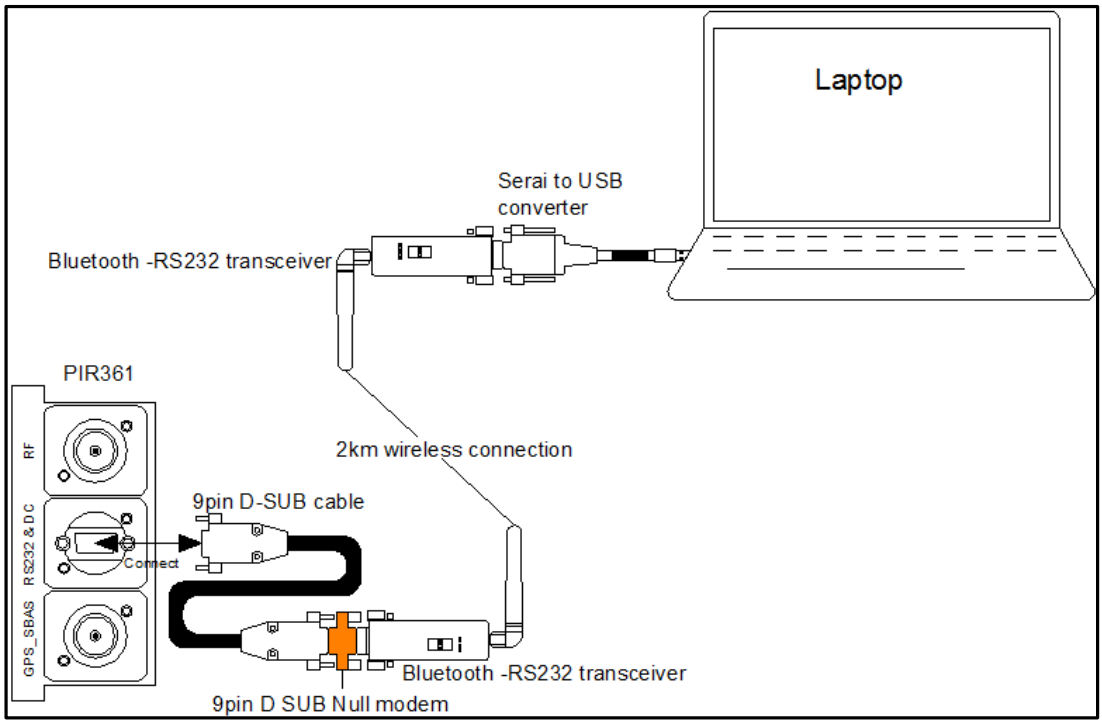
Pressing Esc (sky blue color) will lead LCD screen back to main menu (Figure 11).

Saving the measurement data in a laptop.

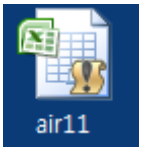
You can connect PIR361 with a laptop either using 9pin DS-SUB cable or using WIFI to RS-232 transceiver. Run air11 program and you can save measurement data as excel format.



PIR316 connection with a laptop via 9pin D_SUB cable. (Figure 15)

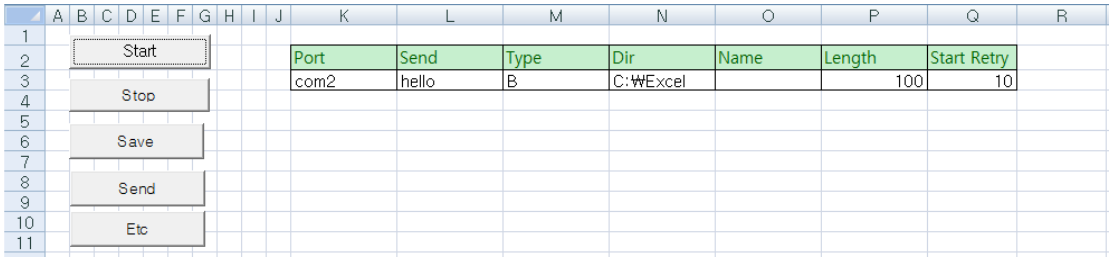


PIR316 connection with a laptop via WIFI RS-232 transceiver. (Figure 16)



air11 program. (Figure 16)

Download air11 program.
Execute air11.
You can see air11 program menu (Figure 17) as below.
Length means how many measurement data you want.
Put the number you want to get.
Figure below Length 100 means you can get 100 measurement data.



air11 program menu. (Figure 17)

Click Start box.
You can get air11 program menu data capture. (Figure 18)

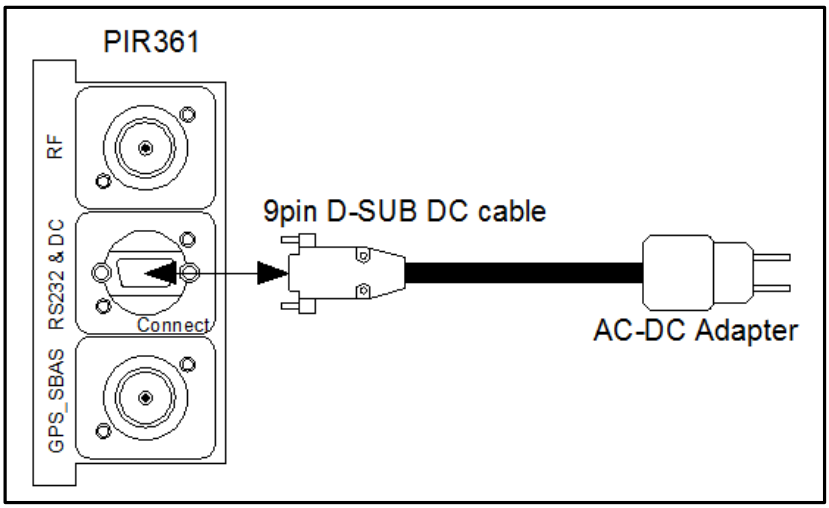
Z54

	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	-55.8	14.0	30.0	29.4	9999.9	485.7	30.0	32.8	16.19	1020	6.6		N	3729.07	E	12707.2	84.80	0.0	25	61
2	-55.6	14.1	30.0	29.4	9999.9	485.7	30.0	32.9	16.19	1020	6.6		N	3729.07	E	12707.2	84.80	0.0	25	61
3	-55.5	13.9	30.0	29.4	9999.9	485.6	30.0	33.0	16.18	1020	6.6		N	3729.07	E	12707.2	84.80	0.0	25	61
4	-55.5	14.1	30.0	29.5	9999.9	485.1	30.0	33.1	16.17	1020	6.6		N	3729.07	E	12707.2	84.90	0.0	25	61
5	-55.4	13.9	30.0	29.6	9999.9	485.0	30.0	33.0	16.16	1018	6.8		N	3729.07	E	12707.2	84.90	0.0	25	60
6	-55.6	13.7	30.0	29.7	9999.9	484.8	30.0	33.1	16.16	1020	7.2		N	3729.07	E	12707.2	84.90	0.0	25	60
7	-55.5	13.7	30.0	29.8	10000.0	484.5	30.0	33.3	16.15	1019	6.9		N	3729.07	E	12707.2	84.90	0.0	25	60
8	-55.5	13.8	30.0	29.7	10000.0	484.3	30.0	33.5	16.14	1033	6.1		N	3729.07	E	12707.2	85.00	0.0	25	60
9	-55.5	13.7	30.0	29.9	10000.0	484.2	30.0	33.6	16.14	1033	6.1		N	3729.07	E	12707.2	85.00	0.0	25	60
10	-55.4	13.5	30.0	29.9	10000.0	483.9	30.0	33.4	16.13	1033	6.1		N	3729.07	E	12707.2	85.10	0.0	25	60
11	-55.5	13.6	30.0	30.1	10001.1	483.9	30.0	33.6	16.13	1033	6.1		N	3729.07	E	12707.2	85.10	0.0	25	61
12	-55.4	13.6	30.0	30.1	10001.1	483.7	30.0	33.8	16.12	1033	6.1		N	3729.07	E	12707.2	85.20	0.0	25	60
13	-55.4	13.6	30.0	30.3	10001.1	483.4	30.0	33.8	16.11	1019	7.0		N	3729.07	E	12707.2	85.20	0.0	25	60
14	-55.4	13.7	30.0	30.4	10001.1	483.3	30.0	33.9	16.11	1011	6.6		N	3729.07	E	12707.2	85.30	0.0	25	60
15	-55.5	13.5	30.0	30.5	10001.1	483.3	30.0	34.1	16.10	1020	7.1		N	3729.07	E	12707.2	85.30	0.0	25	60
16	-55.4	13.5	30.0	30.8	10002.2	483.1	30.0	34.3	16.10	1034	6.4		N	3729.07	E	12707.2	85.40	0.0	25	60
17	-55.3	13.4	30.0	30.7	10002.2	483.3	30.0	34.5	16.11	1034	6.4		N	3729.07	E	12707.2	85.50	0.0	25	60
18	-55.1	13.4	30.0	30.8	10002.2	483.2	30.0	34.5	16.11	1034	6.4		N	3729.07	E	12707.2	85.50	0.0	25	60
19	-55.3	13.5	30.0	31.1	10002.2	483.3	30.0	34.7	16.11	1034	6.4		N	3729.07	E	12707.2	85.50	0.0	25	60
20	-55.4	13.6	30.0	31.2	10002.2	483.3	30.0	34.8	16.11	1018	7.2		N	3729.07	E	12707.2	85.60	0.0	25	60
21	-55.7	13.6	30.0	31.3	10002.2	483.4	30.0	35.2	16.11	1022	7.3		N	3729.07	E	12707.2	85.60	0.0	25	60
22	-55.5	13.7	30.0	31.3	10002.2	483.5	30.0	35.2	16.11	1027	7.1		N	3729.07	E	12707.2	85.60	0.0	25	60
23	-55.3	13.7	30.0	31.6	10002.2	483.6	30.0	35.5	16.12	1019	7.3		N	3729.07	E	12707.2	85.60	0.0	25	60
24	-55.3	13.7	30.0	31.6	10002.2	483.8	30.0	35.6	16.12	1020	7.4		N	3729.07	E	12707.2	85.60	0.0	25	60
25	-55.3	13.4	30.0	31.8	10002.2	483.8	30.0	35.6	16.13	1020	7.4		N	3729.07	E	12707.2	85.70	0.0	25	60
26	-55.3	13.6	30.0	32.0	10002.2	484.0	30.0	35.8	16.13	1020	7.4		N	3729.07	E	12707.2	85.70	0.0	25	60
27	-55.4	13.3	30.0	32.1	10002.2	484.0	30.0	36.0	16.13	1020	7.4		N	3729.07	E	12707.2	85.70	0.0	25	60

air11 program menu data capture. (Figure 18)

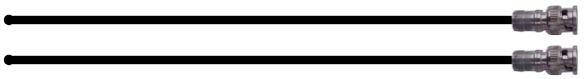
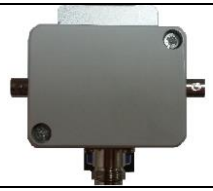
Charging the battery

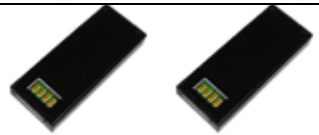
You can charge the battery of PIR361 with AC-DC adapter.



AC-DC adapter connection for battery charging. (Figure 19)

Accessary

Item	Part number	Manufacturer or vendor	Figure (Not to scale)	Unit/Price
RF cable 4meter BNC male –BNC male 50Ω	KAV-RF-CABLE1	Kavics		30.0 US Dollar
Antenna Dual band F1:108~118MHz VSWR1.5:1 F2:329~335MHz VSWR1.5:1	KAV-ANT1	Kavics		50.0 US Dollar
Antenna assembly BNC female N male	KAV-ANT-ASEM1	Kavics		100.0 US Dollar
External Low Noise Amplifier SMA female input BNC male output Noise figure: 0.5dB Gain 108~118MHz: 23dB 329~335MHz: 19dB DC: +5Vdc@60mA	KAV-EL361	Kavics		130.0 US Dollar
GPS active antenna SMA male	AA.162.301111	Taoglas Mouser or Digi-key Purchasable.		20.0 US Dollar
BNC male to SMA female For GPS antenna mating	0733860031 or equivalent.	Molex.LLC Mouser or Digi-key Purchasable.		40.0 US Dollar

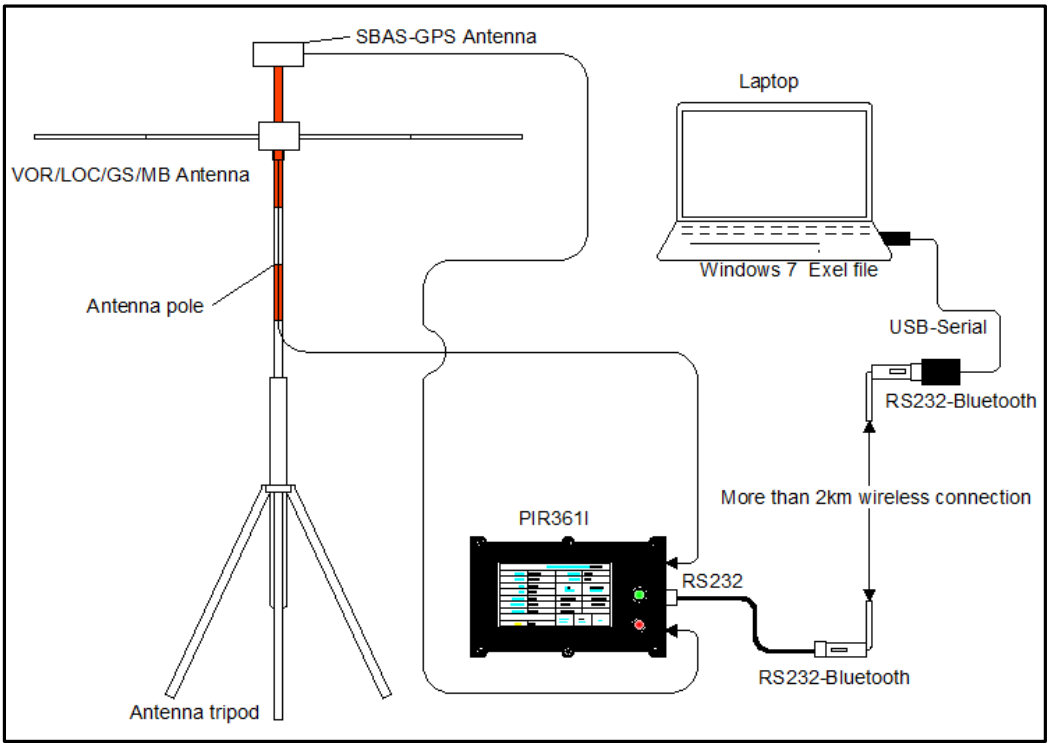
Antenna pole 2meter telescopic	HI-22	TEAYANG Measures CO.,Ltd Korea		30.0 US Dollar
Antenna tripod only	PPT	TEAYANG Measures CO.,Ltd Korea		60.0 US Dollar
2.4GHz Blue tooth RS232 Transceiver	PARANI-SD1000	SENA NETWORKS Korea		100.0 US Dollar
2.4GHz Blue tooth RS232 Transceiver Li-Ion battery pack	BPC-G02	SENA NETWORKS Korea		30.0 US Dollar
2.4GHz Blue tooth RS232 Transceiver 5dBi dipole antenna	DTA5-G01R	SENA NETWORKS Korea		10.0 US Dollar
2.4GHz Blue tooth RS232 Transceiver battery charger DC adapter.	OPA-G01	SENA NETWORKS Korea		20.0 US Dollar

DB9 Null modem For PIR361 bluetooth to RS-232 connection.	DB9 Null modem Mini M/F	US converters Mouser or Digi-key Purchasable.		10.0 US Dollar
9pin D-SUB cable female to female for RS-232 data connection.	9pin D-SUB cable	Kavics		10.0 US Dollar
USB to serial converter	XS881 or equivalent.	US converters Mouser or Digi-key Purchasable.		40.0 US Dollar
AC-DC Adapter AC110~220V to +5Vdc	PSA05A-050QL6-H Or equivalent.	Phihong USA Mouser or Digi-key Purchasable.		10.0 US Dollar
9pin D-SUB female to USB For battery charge.	9pin D-SUB DC cable	Kavics		10.0 US Dollar
USB memory stick Air11 program. PIR361 operating manual.	4Giga or equivalent.	Sandisk		Not for sales

Table 6 Accessary included.

- Prices are subject to change for currency exchange rate or stock status.
- Some of accessary items can be purchased on Mouser, Digi-key except ILS/VOR antenna and antenna assembly.
- RS-232 data cables can be easily assembled with hoods and screws.

Field application of PIR361



Ground check application. (Figure 20)

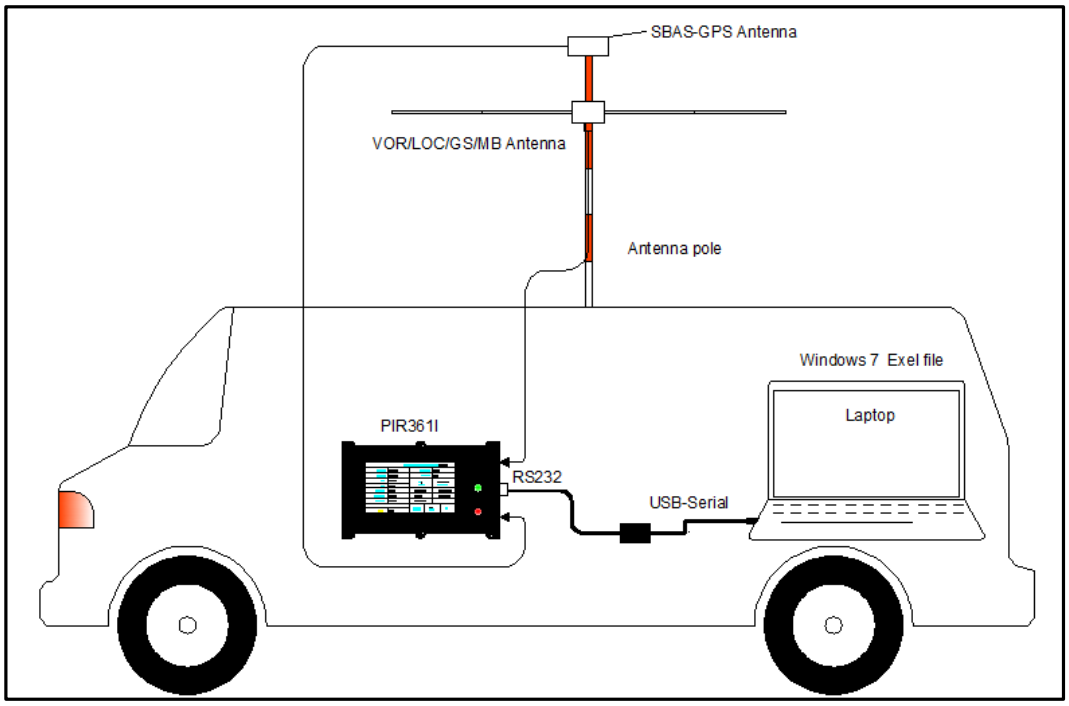
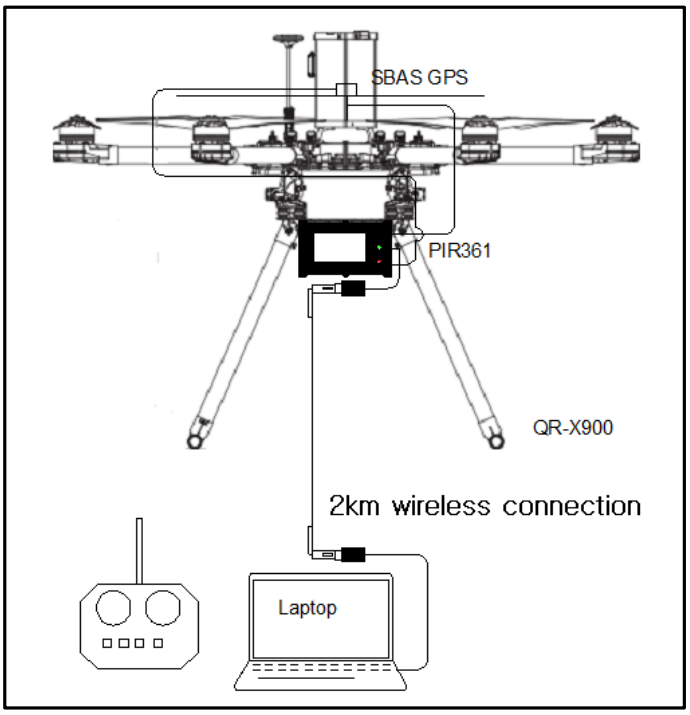
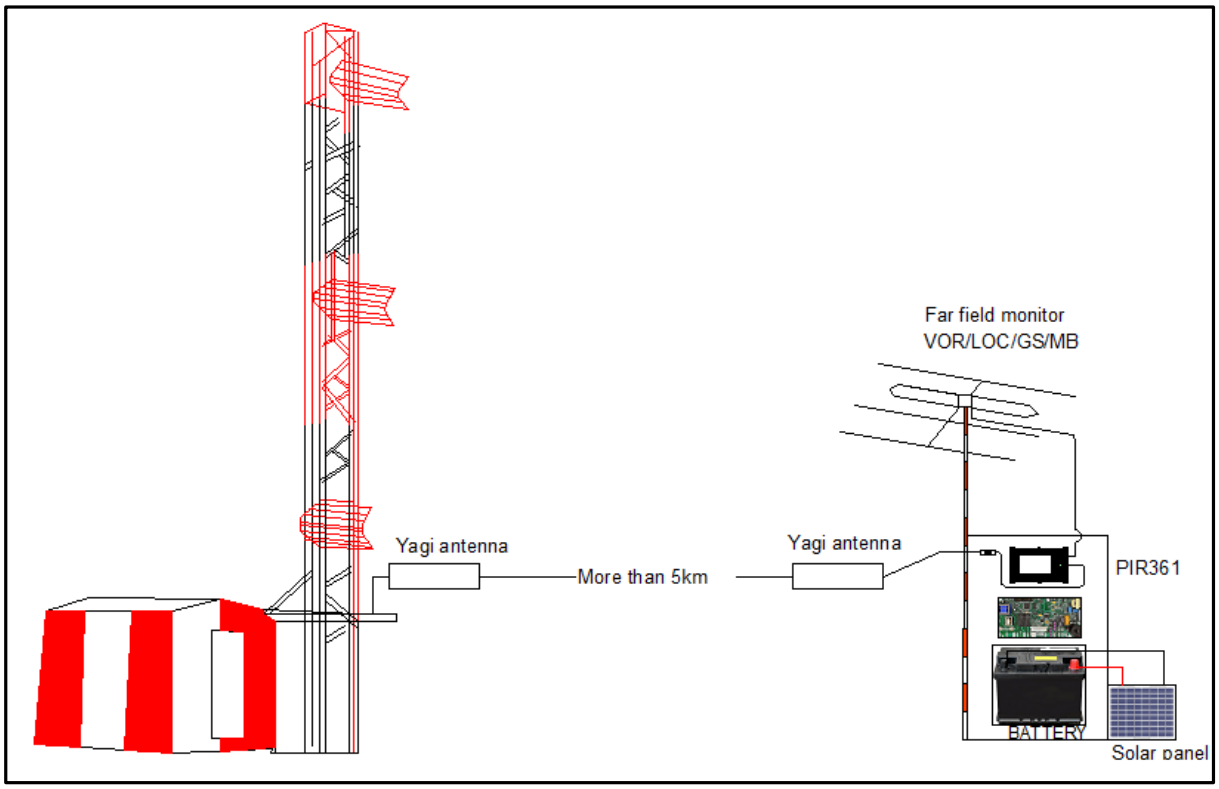


Figure 5 Vehicle ground check application. (Figure 21)



Drone ground check application. (Figure 22)



Solar panel powered far field monitor for each of LOC GS VOR MB without power & network construction. (Figure 23)

Appendix

Ground test requirements for ILS performance Categories I, II, and III Localizers

Parameter	Annex 10,Vol 1	Doc 8071, Vol 1	Measurand	Tolerance (See Note1)	Uncertainty	Periodicity
Orientation	3.1.3.1		Orientation	correct		Annual
Frequency	3.1.3.2.1	4.2.12	Frequency	Frequency Single 0.005% Frequency Dual 0.002% Separation: >5 kHz <14 kHz.	0.001% 0.005%	Annual
Spurious modulation	3.1.3.2.3		DDM, Deviation	<0.005 DDM peak-to-peak	0.001DDM	Quarterly
Coverage (usable distance)	3.1.3.3.1	4.2.13	Power	As set at commissioning. See Note 2.	1dB	Quarterly
Course structure (Category III only)	3.1.3.4	4.2.8, 4.2.9	DDM	As described in Annex 10.	0.001DDM	Quarterly
Carrier modulation - Balance - Depth	3.1.3.5.1	4.2.15	DDM Depth	Within 10 uA of the modulation balance value. 18-22%	0.001DDM 0.2%	Quarterly
Carrier modulation frequency	3.1.3.5.3	4.2.14	Frequency	Cat I: 12.5% Cat II: 11.5% Cat III: 11%	0.1%	Annual
Carrier modulation harmonic content (90 Hz)	3.1.3.5.3 d)	4.2.17	Total 2nd harmonic	<10% <5% (Cat III)	0.5%	Annual
Carrier modulation harmonic content (150 Hz)	3.1.3.5.3 e)	4.2.17	Total 2nd harmonic	<10% <5% (Cat III)	0.5%	Annual
Unwanted modulation	3.1.3.5.3.2		Ripple	Modulation depth <0.5%	0.1%	Semi-annual
Phase of modulation tones	3.1.3.5.3.3	4.2.18 to 4.2.20	LF phase	Cat I, II: <20° Cat III:< 10°	4° 2°	Annual
Phase of modulation tones dual frequency systems (each carrier and between carriers)	3.1.3.5.3.4	4.2.18 to 4.2.20	LF phase	Cat I, II: <20° Cat III:< 10°	4° 2°	Annual
Phasing of alternative systems	3.1.3.5.3.5	4.2.18to 4.2.20	LF phase	Cat I, II: nominal ±20° Cat III: nominal ±10°	4° 2°	Annual

Sum of modulation depths	3.1.3.5.3.6	4.2.15	Modulation depth	Modulation depth<95%	2%	Quarterly
Sum of modulation depths when using radiotelephony communications	3.1.3.5.3.7	4.2.15	Modulation depth	Modulation depth <65% ±10°, <78% beyond 10°	2%	Quarterly
Course alignment	3.1.3.6.1	4.2.8, 4.2.9	DDM Distance	Cat I: <10.5 m. See Note 2. Cat II: < 7.5m Cat III: < 3 m	0.3m	I - Quarterly II- Monthly III -Weekly
Displacement sensitivity	3.1.3.7	4.2.10		0.00145 nominal. See Note 2. Cat I, II: 117% Cat III: 110%	±13% ±12%	I,II- Quarterly III- Monthly
Peak modulation depth	3.1.3.8.3.2		Modulation depth	<50%	2%	Quarterly
Audio frequency characteristic	3.1.3.8.3.3		Modulation depth	±3dB	1dB	Annual
Identification tone frequency Il I	3.1.3.9.2		Tone frequency	1020±50 Hz	5Hz	Annual
Identification modulation depth	3.1.3.9.2		Modulation depth	As commissioned	1%	Quarterly
Identification speed	3.1.3.9.4		Tone frequency	1020±50 Hz	1%	
Identification repetition rate	3.1.3.9.4		Time	As commissioned		
Phase modulation	3.1.3.5.4	4.2.21 to 4.2.23	Peak deviation	Limits given in FM /PM radians: see Note 5. 90Hz 150 Hz (Difference Hz) Cat I: 135/1.5 135/0.9 45 Cat II: 60/0.66 60/0.4 20 Cat III: 45/0.5 45/0.3 15	 10Hz 5Hz 5Hz	3years
Monitoring - Course shift	3.1.3.1 1.2	4.2.25	DDM distance	See Note2 Monitor must alarm for a shift in the main course line from the runway center line equivalent to or more than the following distances at the ILS reference datum.		I - Quarterly II- Monthly III -Weekly See Notes 3 and 4

				Cat I: 10.5 m (35 ft) Cat II: 7.5 m (25 ft) Cat III: 6.0 m (20 ft)	2m 1m 0.7 m	
-Change in displacement sensitivity	3.1.3.11.2 f)	4.2.26	DDM Distance	Monitor must alarm for a change in displacement sensitivity to a value differing from the nominal value by more than: Cat I: 17% Cat II: 17% Cat III: 17% Required only for certain types of localizer.	 ±0.3% ±0.3% ±0.3%	I - Quarterly II- Monthly III -Weekly See Notes 3 and 4
- Clearance signal				Monitor must alarm when the off-course clearance cross-pointer deflection falls below 150 uA anywhere in the off-course coverage area.	±5uA	
- Reduction in power	3.1.3.11.2 d) and e)	4.2.27	Power field strength	Monitor must alarm either for a power reduction of 3 dB, or when the coverage falls below the requirement for the facility, whichever is the smaller change.	±1dB relative	
-Total time, out-of-tolerance radiation	3.1.3.11.3	4.2.24	Time	For two-frequency localizers, the monitor must alarm for a change of ±1dB in either carrier, unless tests have proved that use of the wider limit above will not cause unacceptable signal degradation (>150u A in clearance sector) Cat I: 10 s Cat II: 5 s Cat III : 2 s	±5uA 0.2s	

Note

1. In general, the equipment settings should not be modified if the listed parameters are within 50 per cent of tolerance. See 4.2.54 and 4.2.55.

2. After the commissioning, flight check for the localizer, ground measurements of course alignment, displacement sensitivity, and power output should be made, both for normal and monitor alarm conditions. These measurements should be noted and used as reference in subsequent routine check measurements.

3. The periodicity for monitor tests may be increased if supported by an analysis of integrity and stability history.

4. These tests also apply to those parameters measured by the far-field monitor, if installed.

5. This measurement applies to the difference in peak frequency deviation between the separate measurements of the undesired 90 Hz FM (or equivalent PM) and the 150 Hz FM, using the filters specified in the table in 4.2.23.

Ground test requirements for ILS performance
Categories I, II, and III Glide slope

Parameter	Annex 10,Vol 1	Doc 8071, Vol 1	Measurand	Tolerance (See Note1)	Uncertainty	Periodicity
Orientation	3.1.5.1.1		Orientation	correct		Annual
Path angle	3.1.5.1.2.2	4.2.29 to 4.2.3 1	DDM Angle	See Note 2. Cat I: Within 7.5% of nominal angle Cat II: Within 7.5% of nominal angle Cat III: Within 4% of nominal angle	 Cat I: 0.75% Cat II:0.75% Cat III: 0.4%	Quarterly
Frequency	3.1 52.1	4.2.34	Frequency	Frequency Single 0.005% Frequency Dual 0.002% Separation: >4 kHz <32 kHz.	0.001% 0.0005% 0.0005%	Annual
Unwanted modulation	3.1.5.2.3		DDM	<0.002DDM peak-to-peak	0.004DDM	Semi-annual
Coverage (usable distance)	3.1.5.3	4.2.35	Power	As commissioned See Note 2.	1dB	Quarterly
Carrier modulation - Balance - Depth	3.1.5.5.1	4.2.37	DDM Depth	 0.002DDM 37.5% to 42.5% for each tone	 0.001DDM 0.5%	Quarterly
Carrier modulation frequency	3.1.5.5.2 a), b), and c)	4.2.36	Frequency Of modulation tone	Cat I: 2.5% Cat II: 1.5% Cat III: 1%	0.01%	Annual
Carrier modulation harmonic content (90 Hz)	3.1.5.5.2 d)	4.2.38	Total 2nd harmonic	<10% <5% (Cat III)	0.5%	Annual
Carrier modulation harmonic content (150 Hz)	3.1.5.5.2 e)	4.2.38	Total 2nd harmonic	<10% <5% (Cat III)	0.5%	Annual
Unwanted amplitude modulation	3.1.5.5.2.2		Ripple	<1%	0.1%	Semi-annual
Phase of modulation tones	3.1.5.5.3	4.2.39	Phase	Cat I, II: <20° Cat III:< 10°	4° 2°	Annual
Phase of modulation tones dual frequency systems (each carrier and between carriers)	3.1.5.5.3.1	4.2.39	Phase	Cat I, II: <20° Cat III:< 10°	4° 2°	Annual
Phasing modulation tones, alternative systems	3.1 .5.5.3.2	4.2.39	Phase	Cat I, II: nominal ±20° Cat III: nominal ±10°	4° 2°	Annual

Displacement sensitivity	3.1 5.6	4.2.32	DDM Angle	See Note 2.	Cat I: 2.5% Cat II: 2.0% Cat III: 1.5%	Quarterly Quarterly Monthly
Phase modulation	3.1.5.5.4		Peak deviation	Limits given in FM Hz / PM radians: See Note 5. 90 Hz 150 Hz Difference (Hz) Cat I: 150/0.66 150/1.0 50 Cat II, III: 90/1.0 90/0.6 30	 10Hz 10Hz	3years
Monitoring (See Note 4) - Path angle	3.1.5.7.1 a)	4.2.42	DDM, Angle	See Note 2. Monitor must alarm for a change in angle of 7.5% of the promulgated angle.	±4uA	I II - Quarterly III -Monthly
-Change in displacement sensitivity	3.1.5.7.1 d), e)	4.2.43	DDM, Angle	Cat I: , Monitor must alarm for a change in the angle between t glide path and the line below the glide path at which 75uA is obtained, by more than 3.75% of path angle. Cat II: Monitor must alarm for a change in displacement sensitivity by more than 25%. Cat III: Monitor must alarm for a change in displacement sensitivity by more than 25%.		
- Reduction in power	3.1.5.7.1 b), c)	4.2.44	Power	Monitor must alarm either for a power reduction of 3 dB, or when the coverage falls below the requirement for the facility, whichever is the smaller change. Monitor must alarm either for a power reduction of 3 dB, or when the coverage falls below the requirement for the facility, whichever is the	±1dB ±0.5dB	

-Clearance signal	3.1.5.7.1 g)		DDM, Angle	smaller change. For two-frequency glide slope, the monitor must alarm for a change of ±1dB in either carrier, unless tests Monitor must alarm for DDM ~0.175 below path clearance area		
-Total time, out-of-tolerance radiation	3.1 5.7.3.1	4.2.24	Time	Cat I: 6 s Cat II, III: 2 s		

Note
1) In general, the equipment settings should not be modified if the listed parameters are within 50per cent of the given tolerances. See 4.2.54 and 4.2.55.
2a) After the commissioning, flight check for the glide path, ground measurements of glide path angle, displacement sensitivity, and clearance below path, may be made, both for normal and monitor alarm conditions. These measurements may be used as reference in subsequent routine check measurements.
2b) After the commissioning, flight check for the glide path and ground measurements of the glide path power should be made, both for normal and monitor alarm conditions. These measurement may be used as reference in subsequent routine check measurements.
3. The tolerances given are for routine checks only. All parameters should be set to nominal values at the time of commissioning.
4. The periodicity for monitor tests may be increased if supported by an analysis of integrity and stability history.
5. This measurement applies to the difference in peak frequency deviation between the separate measurements of the undesired 90 Hz FM (or equivalent PM) and the 150 Hz FM, using the filters specified in the table in 4.2.23.

Ground test requirements – VOR

Parameter	Annex 10 Vol 1	Doc 8071, Vol 1	Measurand	Tolerance	Uncertainty	Periodicity
Rotation	3.3.1.1	2.2.4	Clockwise	Correct		12 months
Sensing	3.3.1.3	2.2.5	Correctness	Correct		12 months
Carrier frequency	3.3.2	2.2.6	Frequency	±.002%	0.0004%	12 months
Polarization	3.3.3.1 "	2.2.34	Deviation	±2.0°	±0.3°	12 months
Pattern accuracy	3.3.3.2	2.2.7 2.2.8	Alignment	±2.0°	±0.3°	12 months
Coverage	3.3.4	2.2.9	Field strength	90 uV/m	3dB	12 months
9960 Hz deviation	3.3.5.1	2.2.11	Ratio	16±1		12 months
9960Hz modulation depth	3.3.5.2	2.2.12	Modulation depth	28 to 32%	1%	12 months
30Hz modulation depth	3.3.5.3	2.2.12 to 2.2.15	Modulation depth	28 to 32%	1%	12 months
30Hz modulation frequency	3.3.5.4	2.2.19	Frequency	30Hz±1%	0.06 Hz	12 months
9960Hz subcarrier frequency	3.3.5.5	2.2.20	Frequency	9960Hz ±1 %	20 Hz	12 months
CVOR AM modulation of 9960 Hz subcarrier	3.3.5.6	2.2.21	Modulation depth	≤5%	1%	12 months
DVOR AM modulation of 9960 Hz subcarrier	3.3.5.6	2.2.22	Modulation depth	≤40%	1%	12 months
Sideband level of harmonics of 9960 Hz	3.3.5.7	2.2.23	Modulation depth 2nd harmonic 3rd harmonic 4th and above	9960 Hz = 0dB ref. ≤-30dB ≤-50dB ≤-60 dB	1 dB	12 months
Peak modulation of voice channel	3.3.6.2	2.2.24	Modulation depth	≤ 30%	1%	12 months
Audio frequency characteristics	3.3.6.3	2.2.25	Power	±3 dB	1dB	12 months
Identification speed	3.3.6.5	2.2.27	Time	7 words/min		12 months
Identification repetition	3.3.6.5	2.2.28	Time	≥2 time/min		12 months
Identification tone frequency	3.3.6.5	2.2.29	Frequency	1020±50 Hz	10 Hz	12 months
Identification modulation depth With communications channel No communications channel I	3.3.6.6	2.2.30	Modulation depth	 ≤10% ≤20%		12 months
Speech effect on navigation function Deviation Modulation	3.3.6.7	2.2.26	 Deviation Modulation		 0.3% 1%	12 months
Bearing monitor	3.3.7.1	2.2.32	Deviation	±1.0°	0.3°	12 months
Modulation monitor	3.3.7.1	2.2.33	Volts	15%	1%	12 months
Spurious modulation	None	2.2.35	Modulation depth	≤0.5%	0.1%	12 months
Site infringement	None	2.2.36				12 months

Ground test requirements – ILS Marker Beacon

Parameter	Annex 10,Vol 1	Doc 8071, Vol 1	Measurand	Tolerance (See Note1)	Uncertainty	Periodicity
Frequency	3.1.7.2.1	4.2.45	Frequency	±0.01% (0.005% recommended)	0.00 1 %	Annual
RF output power		4.2.46	Power	±15%	5%	Quarterly
Carrier modulation	3.1.7.4.2	4.2.47	Modulation depth	91-99%	2%	Quarterly
Carrier modulation frequency	3.1.7.4.1	4.2.48	Frequency of tone	Nominal 12.5%	0.0 1 %	Semi-annual
Carrier modulation harmonic content		4.2.49	Modulation depth	Total<15%	1%	Annual
Keying	3.1.7.5.1	4.2.50	Keying	Proper keying, clearly audible OM: 400 Hz, 2 dashes per second continuously. MM: 1300 Hz, alternate dots and dashes continuously. IM: The sequence being repeated once per second. 3000 Hz, 6 dots per second continuously.	 ±0.1s ±0.1s ±0.3s	Quarterly
Monitor system - Carrier power - Modulation depth - Keying	3.1.7.7.1	4.2.51	 Power Percent Presence	Alarm at: -3 dB >50 % Loss or continuous	 1dB 2%	Quarterly See Note 2.

Notes:

1. The tolerances given are for routine checks only. All parameters should be set to nominal values at the time of commissioning.

2. The periodicity for monitor tests may be increased if supported by an analysis of integrity and stability history.