

AP912-102

DTS Controller

for

Portable Radio

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Revision History

<u>Rev.</u>	<u>Date</u>	<u>By</u>	<u>Description</u>
0.10	28 December, 2000		First Draft
0.12	13 January, 2001		Add +5 function to the application circuit
0.13	15 March, 2001		Add current consumption
0.14	20 August, 2001		Add 64 pin package information
0.15	1 November, 2001		Clarify die drawing and package drawing Add description on SLEEP mode

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1 General Description

The AP912-102 is a single chip digital tuning controller for portable radio used. It supports nearly all the worldwide radio system from FM, MW, SW, LW, TV and Weather bands.

Features

- 10 Preset memories for each band (FM/MW/LW or TV/SW/WB)
- Last channel memory. One station for each band
- Manual tuning and seek tuning.
- Clock function with 12 hour or 24 hour display format
- Alarm timer function
- Dual Clock function
- + 5 key function
- Sleep function with pre-settable sleep time
- Flexible configurations through diode jumper option

2 Block Diagram

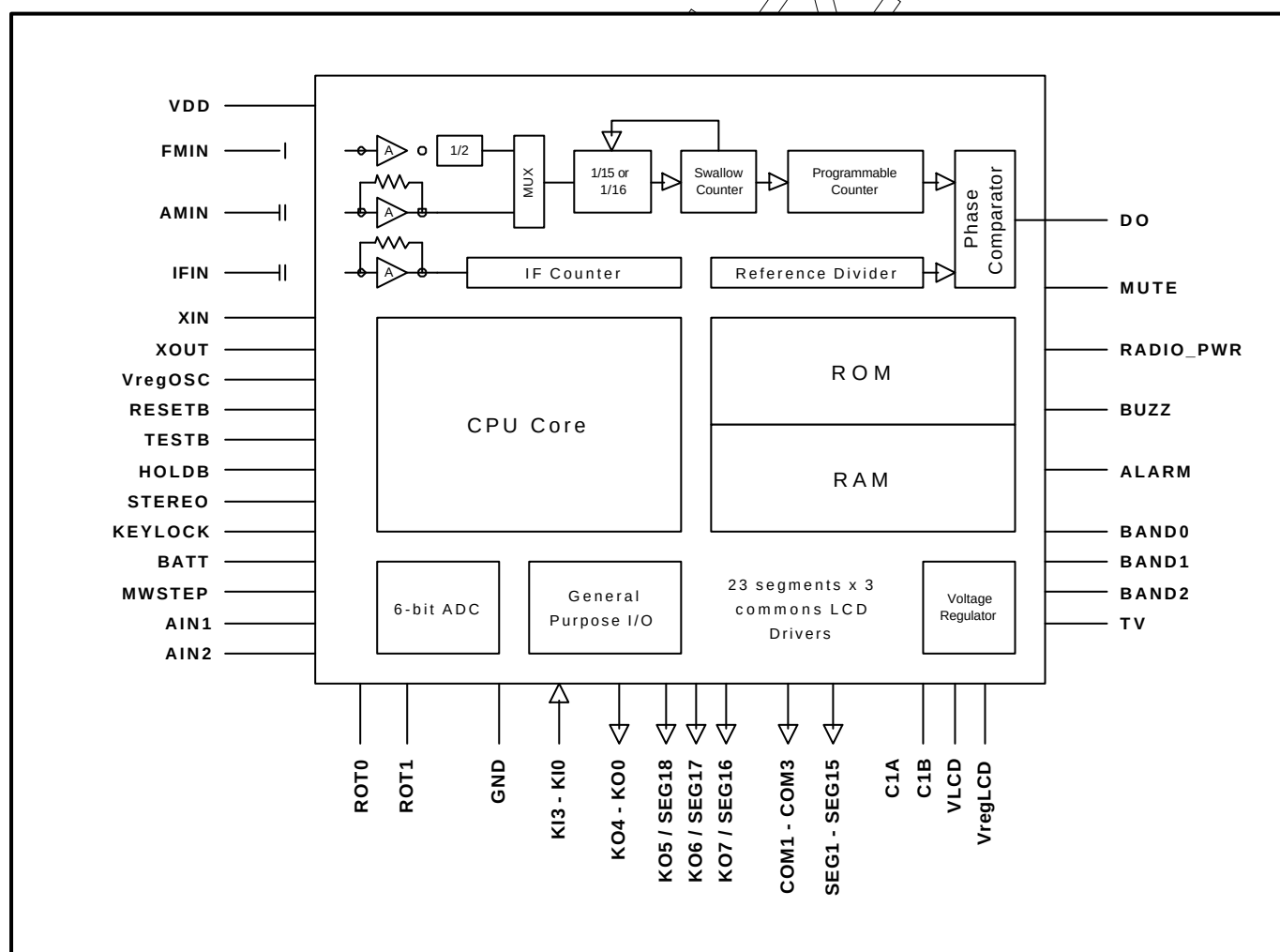


Figure 1 Block Diagram of AP912-102

3 Pin Description (66 pads)

Pad #	COB PIN	Package PIN #	Name	Type	Description
1	1		COM1	OL	LCD common driver output
2	2		COM2	OL	LCD common driver output
3	3		COM3	OL	LCD common driver output
4	4		SEG1	OL	LCD segment driver output
5	5		SEG2	OL	LCD segment driver output
6	6		SEG3	OL	LCD segment driver output
7	7		SEG4	OL	LCD segment driver output
8	8		SEG5	OL	LCD segment driver output
9	9		SEG6	OL	LCD segment driver output
10	10		SEG7	OL	LCD segment driver output
11	11		SEG8	OL	LCD segment driver output
12	12		SEG9	OL	LCD segment driver output
13	13		SEG10	OL	LCD segment driver output
14	14		SEG11	OL	LCD segment driver output
15	15		SEG12	OL	LCD segment driver output
16	16		SEG13	OL	LCD segment driver output
17	17		SEG14	OL	LCD segment driver output
18	18		SEG15	OL	LCD segment driver output
19	19		SEG16	OL	LCD segment driver output
20	20		SEG17	OL	LCD segment driver output
21	21		SEG18	OL	LCD segment driver output
22	22		SEG19	OL	LCD segment driver output
23	23		SEG20	OL	LCD segment driver output
24	24		SEG21	OL	LCD segment driver output
25	25		SEG22	OL	LCD segment driver output
26	26		SEG23	OL	LCD segment driver output
27	27		KI0	ISD	Keyboard scan input
28	28		KI1	ISD	Keyboard scan input
29	29		KI2	ISD	Keyboard scan input
30	30		KI3	ISD	Keyboard scan input
31	31		KO0	O	Keyboard Scan Output
32	32		KO1	O	Keyboard Scan Output
33	33		KO2	O	Keyboard Scan Output
34	34		KO3	O	Keyboard Scan Output
35	35		KO4	O	Keyboard Scan Output
36	36		KO5	O	Keyboard Scan Output
37	N.C.		KO6	O	Keyboard Scan Output
38	N.C.		KO7	O	Keyboard Scan Output
39	37		POWER	I	Tact Switch or Slide Switch for turning on the Radio
40	38		KEYLOCK	I	Keyboard lock. When "1" indicates keyboard locked.
41	39		BAND0	O	Refer to Band switching table
42	40		BAND1	O	
43	41		BAND2	O	
44	42		AIN1	IA	Direct memory input buttons
45	43		AIN2	IA	Direct memory input buttons
46	44		STEREO	I	Stereo reception indication "0" MONO mode "1" STEREO Mode, stereo icon will lit
47	45		BATLOW	I	Low battery input "0" - BATT indicator will flash "1" - BATT indicator off
48	46		BUZZ	O	Alarm Buzzer output
49	47		MUTE	O	Active high mute output.
50	48		TESTB	ISU	Reserved for IC test used
51	49		BATTERY	I	BATTERY INPUT "0" - Back up "1" - Normal
52	50		IFIN	IA	IF signal input

Pad #	COB PIN	Package PIN #	Name	Type	Description
53	51		RADIO_PWR	OT2	"H" turn on the radio "L" turn off the radio
54	52		DO	OT	PLL output for VCO
55	53		GND	-	
56	54		FMIN	IA	FM VCO signal input
57	55		AMIN	IA	AM VCO signal input
58	56		VDD	-	
59	57		RESETB	ISU	Active low IC reset.
60	58		XOUT	POSC	75kHz crystal oscillator output
61	59		XIN	POSC	75kHz crystal oscillator input
62	60		VregOSC	A	Regulated supply voltage for crystal oscillator
63	61		VLCD	A	LCD supply voltage
64	62		C1A	A	Voltage doubler capacitor
65	63		C1B	A	
66	64		VregLCD	A	Regulated supply voltage for LCD/drivers

IA : Analog input
 A : Analog I/O pad
 IS : CMOS schmitt trigger input
 ISU : CMOS schmitt trigger input with pull-up
 I : Input Pad

O : Output Pad
 OT : Tri-state output pad
 OA : Analog output pad
 OL : LCD Driver Output Pad
 PSOC : Oscillator Pad

4 Keyboard Layout

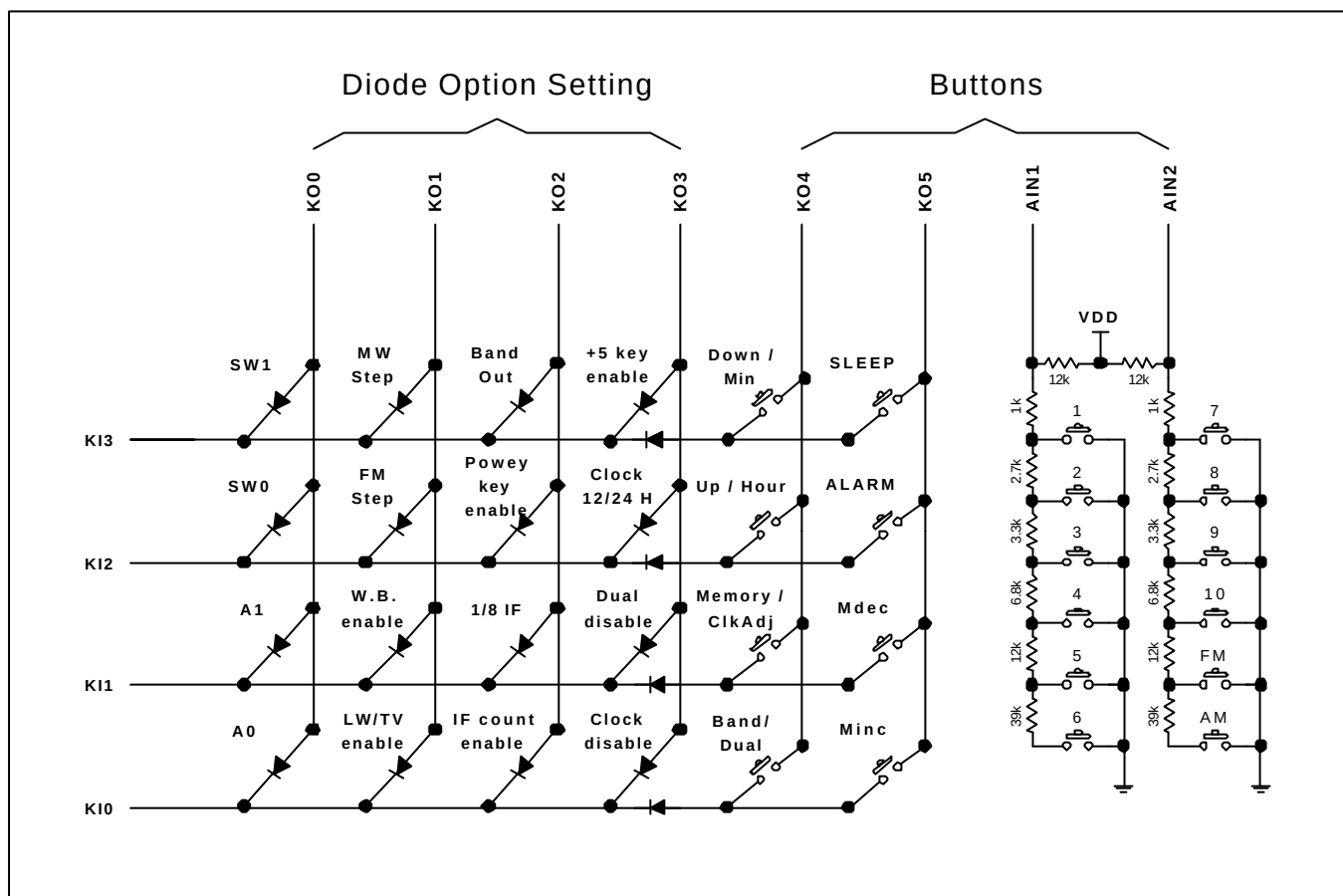


Figure 2 Keyboard Layout

4.1 Option Setting Matrix

The matrix formed by KI0, KI1, KI2, KI3 and KO0, KO1, KO2, KO3 are used to configure the AP912-102 operation. (* with diode – “1”, without diode – “0”)

4.1.1 Area of Use Option

This option is used to select the area of used.

A1	A0	AREA
Without Diode	Without Diode	U.S.A.
Without Diode	With Diode	General
With Diode	Without Diode	Europe/ E-Europe
With Diode	With Diode	Japan

4.1.2 SW Band Option (Level Count)

This option is used to select for SW band.

SW1	SW0	Receiving band (MHz)	Note
Without Diode	Without Diode	No SW	
Without Diode	With Diode	5.95 ~ 15.6	SW A
With Diode	Without Diode	3.80 ~ 12.50	SW B

4.1.3 MW Step Option

This option is used to select for the step size of the MW band.

AM STEP	Description
With Diode	10kHz step
Without Diode	9kHz step

4.1.4 FM Step Selection Option (FMSTEP)

This option is used to select for the step size of the MW band.

U.S.A Area:

FM step	Step	FM receiving frequency
Without Diode	200kHz	87.5~108.0MHz
With Diode	50kHz	87.5~108.0MHz

General Area:

FM step	Step	FM receiving frequency
Without Diode	100kHz	87.5~108.0MHz
With Diode	50kHz	87.5~108.0MHz

Europe Area:

FM step	Step	FM receiving frequency
Without Diode	50kHz	65.0~74.0MHz 87.5~108.0MHz
With Diode	50kHz	87.5~108.0MHz

Japan Area(Step = 100kHz):

FM Step	LW/TV enable	FM receiving frequency	TV receiving freq.
Without Diode	Without Diode	76.0 ~ 108.0MHz	---
Without Diode	With Diode	76.0 ~ 108.0MHz	1 ~ 12ch
With Diode	Without Diode	76.0 ~ 3ch	---
With Diode	With Diode	76.0 ~ 90.0MHz	1 ~ 12ch

4.1.5 Weather Band(WB) Option

With Diode	WB enable
Without Diode	WB disable

4.1.6 LW/TV Band Option

This option is used to select for LW or TV band.

With diode	TV enable (Japan, U.S.A.)
With diode	LW enable (other)
Without diode	TV disable (Japan, U.S.A.)
Without diode	LW disable (other)

4.1.7 Band Out Option

This option is used to select band IN/OUT.

With Diode	Band Out
Without Diode	Band In

4.1.8 Power key Option (Slide Switch)

This option is used to select for the type of the Power switch.

Slide Switch	Function
Without Diode	Slide Switch
With Diode	TACT Switch

4.1.9 FM IF Frequency Option (Full IF)

This option is used to select for FM IF frequency in the IF count mode.

1/8 IF	Description
With Diode	1/8 FM IF frequency
Without Diode	FM IF frequency

4.1.10 Level Count Option (Level Count)

This option is used to select for the IF counting or level detection.

IF count enable	Description
With Diode	Enable IF frequency counting
Without Diode	Use signal level detection for tuning induction

4.1.11 +5 Key Option

This option is used to select for the +5 Key.

+5 Key enable	Description
With Diode	+5 Key enable
Without Diode	+5 Key disable

4.1.12 12 Hour / 24 Hour Option (24HOUR)

This option is used to select for the 12 hour display mode or 24 hour display mode.

12H / 24H	Clock Display Mode
Without Diode	12 Hour
With Diode	24 Hour

4.1.13 Dual Clock Option

This option is used to select for the dual clock.

Dual Clock Enable	Description
Without Diode	Dual Clock Enable
With Diode	Dual Clock disable

4.1.14 Clock Selection Option (Clock Disable)

This option is used to select the enable or disable of the real time clock.

CLOCK Disable	Real Time Clock
Without Diode	Enable Clock
With Diode	Disable Clock

4.2 Key Buttons

<u>Name</u>	<u>Type</u>	<u>Description</u>
Down / Min	Button	When radio is on, it is used to tune down the station frequency When radio is off and clock adjust is enable, it is used to adjust the minute time
Up / Hour	Button	When radio is on, it is used to tune up the station frequency When radio is off and clock adjust is enable, it is used to adjust the hour time
Mdec	Button	Decrement button
Minc	Button	Increment button
Memory / ClkAdj	Button	Memory selection or clock adjustment button
BAND / DUAL	Button	Radio frequency band selection when radio is ON In clock mode, two clock is changed cyclically.
POWER	Button / Slide Switch	Button or slide switch to turn on / turn off the Radio
SLEEP	Button	Button to enter or set up SLEEP mode
ALARM	Button	Button to enable / disable alarm.
1	Button	Button to select preset memory 1
2	Button	Button to select preset memory 2
3	Button	Button to select preset memory 3
4	Button	Button to select preset memory 4
5	Button	Button to select preset memory 5
6	Button	Button to select preset memory 6
7	Button	Button to select preset memory 7
8	Button	Button to select preset memory 8
9	Button	Button to select preset memory 9
10	Button	Button to select preset memory 10
+5	Button	Button to select preset memory 6 ~ 10 that added with 1 ~ 5 direct key.
FM	Button	Button to start and confirm "Direct frequency key in mode" in FM band
AM	Button	Button to start and confirm "Direct frequency key in mode" in AM band

5 LCD Layout

5.1 19 segments, 3 commons

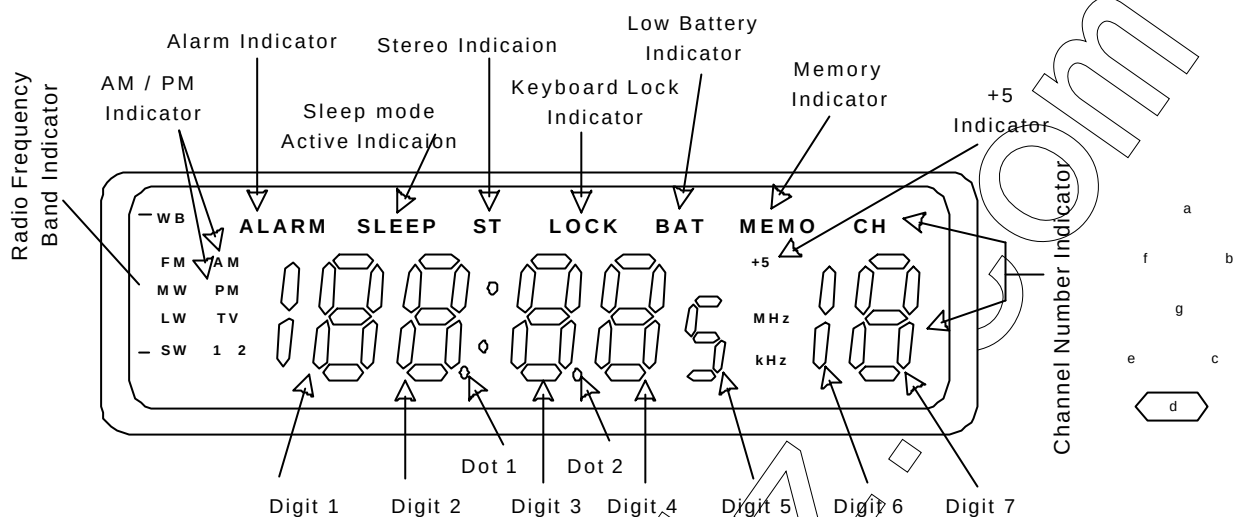


Figure 3 LCD Display

	COM1	COM2	COM3
SEG1	FM	MW	ALARM
SEG2	1	SW	LW
SEG3	2	TV	PM
SEG4	1adeg	AM	SLEEP
SEG5	1c	1b	Colon
SEG6	2e	2f	ST
SEG7	2d	2g	2a
SEG8	Dot1	2c	2b
SEG9	3e	3f	LOCK
SEG10	3d	3g	3a
SEG11	Dot2	3c	3b
SEG12	4e	4f	BATT
SEG13	4d	4g	4a
SEG14	5	4c	4b
SEG15	kHz	MHz	MEMO
SEG16	7e	7f	6b,6c
SEG17	7d	7g	7a
SEG18	CH	7c	7b
SEG19	WB	+5	---

5.2 Frequency of Receiving Band

AREA	BAND	CODE		RECEIVING RANGE [Hz]	STEP [Hz]	Freq. [Hz]	IF [Hz]
		A1	A0				
U.S.A. *1	FM	0	0	87.5 ~ 108.0M	50/200k	25k	10.7M
	MW			522 ~ 1620k	9k	3k	450k
				520 ~ 1710k	10k	5k	
	TV			2 ~ 13ch	1ch	25k	10.7M
	WB			162.400 ~ 162.550M	25k	12.5k	10.7M
General	FM	0	1	87.5 ~ 108.0M	50/100k	25k	10.7M
	MW			522 ~ 1620k	9k	3k	450k
				520 ~ 1620k	10k	5k	
	LW			144 ~ 281k	1k	1k	
Europe East/ Europe *2	FM	1	0	65.0 ~ 74.0M	50k	25k	10.7M
				87.5 ~ 108.0M	50k	25k	10.7M
	MW			531 ~ 1611k	9k	3k	450k
				530 ~ 1610k	10k	5k	
	LW			144 ~ 281k	1k	1k	
Japan *3	FM	1	1	76.0 ~ 108.0M	100k	25k	-10.7M
				76.0 ~ 90.0M	100k	25k	-10.7M
				76.0 ~ 3ch	100k	25k	-10.7M
	MW			522 ~ 1629k	9k	3k	450k
				520 ~ 1620k	10k	5k	
	TV			1 ~ 12ch	1ch	25k	-10.7M
		SW1	SW0				
	SW	0	1	5.95 ~ 15.6M	5k	5k	450k
		1	0	3.8 ~ 12.5M			

*1 If step is 200kHz, range is 87.5 ~ 108.1MHz.

*2 The frequency range of FM in Europe area is according to FMstep jumper.

*3 The frequency range of FM in Japan area is according to FMstep and LW/TV enable jumper.

6 Band Switching Table

- When “BAND OUT” is selected:

Pin	Band0	Band1	Band2
I/O	OUT	OUT	OUT
Function	B0	B1	B2
FM	L	L	L
SW	H	H	L
MW	H	L	L
LW	L	H	L
WB	L	H	H
TV USA	2-6CH	L	L
	7-13CH	L	H
TV JPN	1-3CH	L	L
	4-12CH	L	H

* WB is selected at USA.

- When “BAND IN” is selected:

With [LW/TV enable] diode jumper:

USA/JPN	Pin	Band0	Band1	Band2
	I/O	IN	IN	OUT
	Function	B0	B1	TV OUT
FM		L	L	L
MW		H	L	L
WB		L	H	H
TV USA	2-6CH	H	H	L
	7-13CH	H	H	H
TV JPN	1-3CH	H	H	L
	4-12CH	H	H	H

EUR/GEN	Pin	Band0	Band1	Band2
	I/O	IN	IN	OUT
	Function	B0	B1	TV OUT
FM		L	L	L
SW		H	H	L
MW		H	L	L
LW		L	H	L

*When LW is enable, WB can not be selected.

* When TV is enable, SW can not be selected

* WB is selected at USA

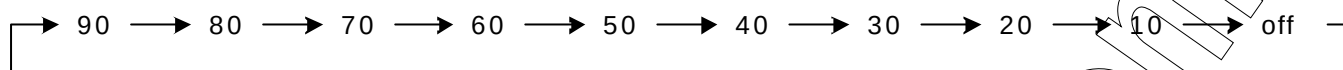
Without [LW/TV enable] diode jumper:

Pin	Band0	Band1	Band2
I/O	IN	IN	OUT
Function	B0	B1	TV OUT
FM	L	L	L
SW	H	H	L
MW	H	L	L
WB	L	H	H

* WB is selected at USA.

7 Sleep Function

When SLEEP Button is pushed, the sleep function will be enabled and the sleep time will be displayed on the LCD for 5 seconds. During the sleep time displayed period, the sleep time can be changed by pressing the SLEEP button. Each push of the SLEEP button will change the SLEEP time according to the following flow:



When Sleep function is enabled, the SLEEP icon on the LCD display will be turned ON.

Sleep is cleared either by pressing the SLEEP button when sleep is active and not in SLEEP time set mode or when sleep time elapsed. After sleep is cleared, the control of the power to the RADIO will be disabled automatically..

8 Electrical Specification

8.1 Absolute Maximum Rating

Item	Symbol	Rating	Unit
Power Supply Voltage (logic)	VDD	-0.5 to 7.0	V
Input Voltage	V _{in}	-0.5 to VDD+0.5	V
Power Dissipation (Ta = 70°C)	P _d	100	mW
Storage Temperature	T _{stg}	-50 to 125	°C
Operating Temperature	T _{opr}	-20 to 70	°C

8.2 Recommended Operating Condition

Item	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	VDD	1.8	-	3.3	V
Input Voltage	V _{in}	0	-	VDD	V
Operating Temperature	T _{opr}	-20	-	70	°C

8.3 Electrical Characteristics

VDD=3.0V unless specified

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
VDD	Supply Voltage		1.8	-	3.3	V
IDD1	Current consumption Standby, no clock display	PLL off, oscillator off		<1		μA
IDD2	Current consumption Standby with clock display	PLL off, oscillator on		60		μA
IDD3	Current consumption – FM tuning	PLL on		6		mA
IDD4	Current consumption – AM tuning	PLL on		5		mA
V _{IH}	Input high voltage		0.8V _{DD}	-	-	V
V _{IL}	Input low voltage		-	-	0.2V _{DD}	V
R _{PU}	Pull-up resistance	V _{IN} = 0V	100K	-	-	Ω
R _{PD}	Pull-down resistance	V _{IN} = VDD	100K	-	-	Ω
V _{ina}	FMIN, AMIN and IFIN input voltage		300		-	mV(pp)
IOL1	Output low current for RADIO_PWR pin	VOL = 0.4V	-	1	-	mA
IOL2	Output low current for MUTE, BUZZER	VOL = 0.4V	-	1	-	mA
IOH1	Output high current for K0 – K5	VOH = VDD - 0.4V	-	1	-	μA

9 Bonding and Package Information

9.1 Bonding Information

AP912-102 bonding pad center coordinates and pin assignment.

Original is located at bottom left corner.

Die Size exclude scribe line 2510μm x 2510μm

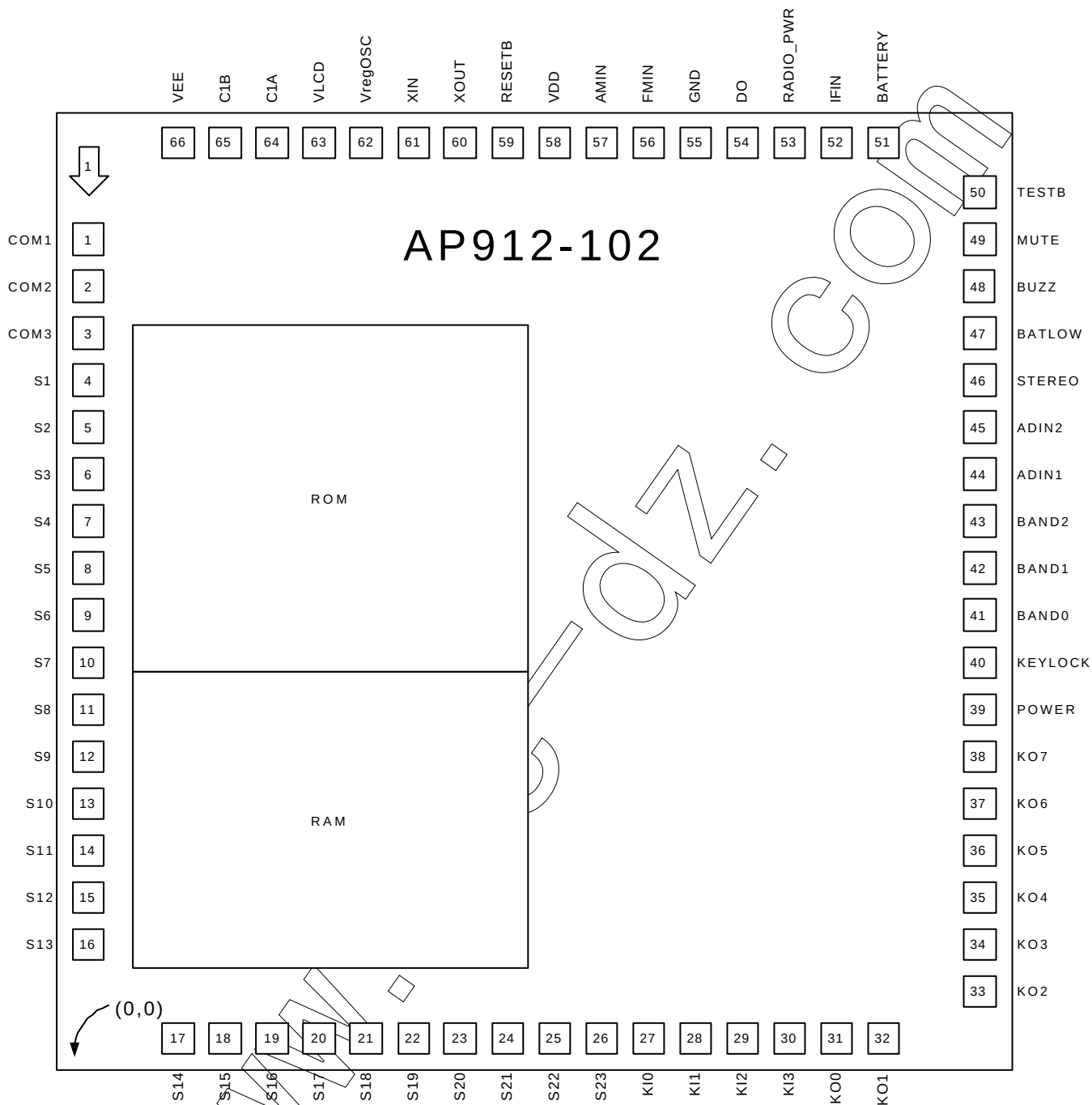
Pad opening 90μm x 90μm

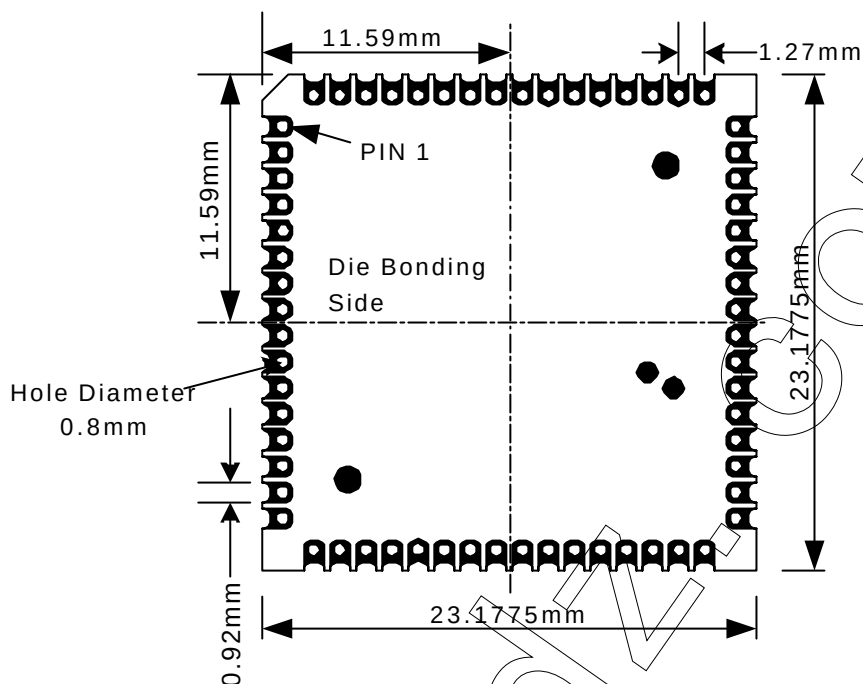
Minimum pad pitch 110μm

Substrate has to be connected to Ground

PAD NO.	PAD NAME.	X-coordinate	Y-coordinate	PAD NO.	PAD NAME.	X-coordinate	Y-coordinate
1	COM1	82.9	2177.5	34	KO3	2427.1	392.5
2	COM2	82.9	2022.5	35	KO4	2427.1	507.5
3	COM3	82.9	1887.5	36	KO5	2427.1	622.5
4	S1	82.9	1772.5	37	KO6	2427.1	737.5
5	S2	82.9	1657.5	38	KO7	2427.1	852.5
6	S3	82.9	1542.5	39	POWER	2427.1	967.5
7	S4	82.9	1427.5	40	KEYLOCK	2427.1	1082.5
8	S5	82.9	1312.5	41	BAND0	2427.1	1197.5
9	S6	82.9	1197.5	42	BAND1	2427.1	1312.5
10	S7	82.9	1082.5	43	BAND2	2427.1	1427.5
11	S8	82.9	967.5	44	ADIN1	2427.1	1542.5
12	S9	82.9	852.5	45	ADIN2	2427.1	1657.5
13	S10	82.9	737.5	46	STEREO	2427.1	1772.5
14	S11	82.9	602.5	47	BATLOW	2427.1	1887.5
15	S12	82.9	487.5	48	BUZZ	2427.1	2002.5
16	S13	82.9	332.5	49	MUTE	2427.1	2117.5
17	S14	332.5	82.9	50	TESTB	2427.1	2277.5
18	S15	487.5	82.9	51	BATTERY	2177.5	2427.1
19	S16	622.5	82.9	52	IFIN	2022.5	2427.1
20	S17	737.5	82.9	53	RADIO_PWR	1887.5	2427.1
21	S18	852.5	82.9	54	DO	1772.5	2427.1
22	S19	967.5	82.9	55	GND	1657.5	2427.1
23	S20	1082.5	82.9	56	FMIN	1542.5	2427.1
24	S21	1197.5	82.9	57	AMIN	1427.5	2427.1
25	S22	1312.5	82.9	58	VDD	1312.5	2427.1
26	S23	1427.5	82.9	59	RESETB	1197.5	2427.1
27	KI0	1542.5	82.9	60	XOUT	1082.5	2427.1
28	KI1	1657.5	82.9	61	XIN	967.5	2427.1
29	KI2	1772.5	82.9	62	VregOSC	852.5	2427.1
30	KI3	1887.5	82.9	63	VLCD	737.5	2427.1
31	KO0	2022.5	82.9	64	C1A	622.5	2427.1
32	KO1	2177.5	82.9	65	C1B	487.5	2427.1
33	KO2	2427.1	232.5	66	VEE	332.5	2427.1

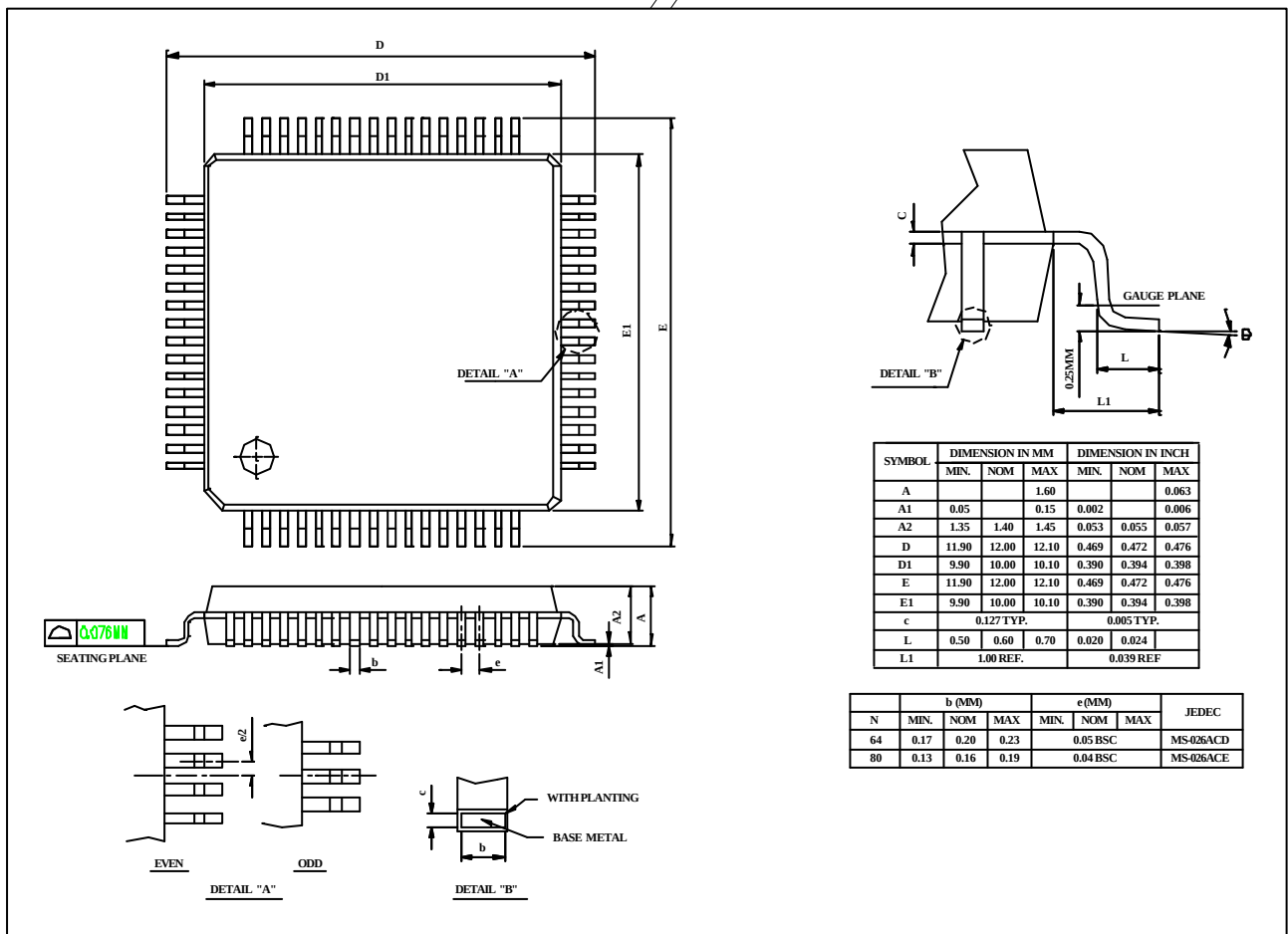
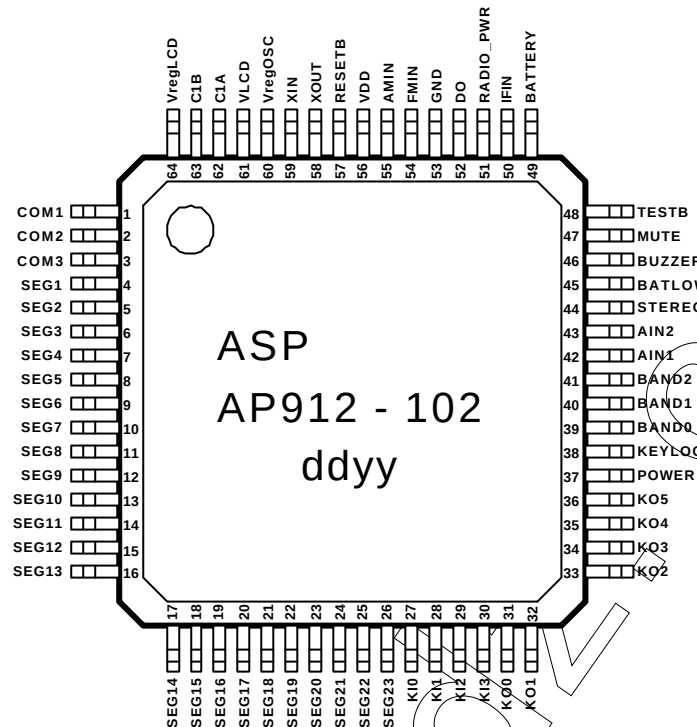
9.2 Die Drawing



9.3 AP912-102COB Pin information


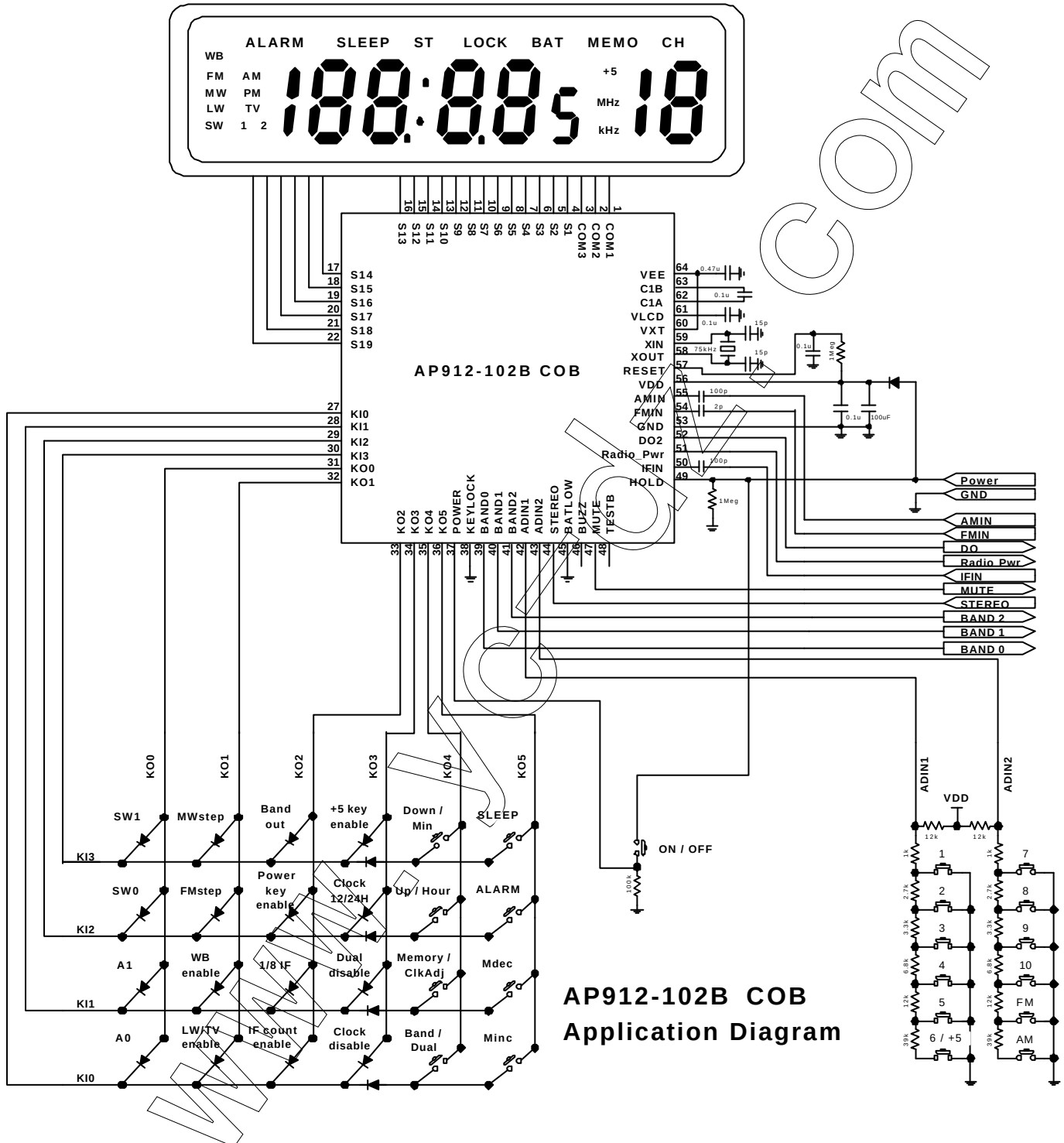
COB Pin No.	Name	Pad No.	COB Pin No.	Name	Pad No.
1	COM1	1	33	KO2	33
2	COM2	2	34	KO3	34
3	COM3	3	35	KO4	35
4	S1	4	36	KO5	36
5	S2	5	37	POWER	39
6	S3	6	38	KEYLOCK	40
7	S4	7	39	BAND0	41
8	S5	8	40	BAND1	42
9	S6	9	41	BAND2	43
10	S7	10	42	ADIN1	44
11	S8	11	43	ADIN2	45
12	S9	12	44	STEREO	46
13	S10	13	45	BATLOW	47
14	S11	14	46	BUZZ	48
15	S12	15	47	MUTE	49
16	S13	16	48	TESTB	50
17	S14	17	49	BATTERY	51
18	S15	18	50	IFIN	52
19	S16	19	51	RADIO_PWR	53
20	S17	20	52	DO	54
21	S18	21	53	GND	55
22	S19	22	54	FMIN	56
23	S20	23	55	AMIN	57
24	S21	24	56	VDD	58
25	S22	25	57	RESETB	59
26	S23	26	58	XOUT	60
27	KI0	27	59	XIN	61
28	KI1	28	60	VregOSC	62
29	KI2	29	61	VLCD	63
30	KI3	30	62	C1A	64
31	KO0	31	63	C1B	65
32	KO1	32	64	VEE	66

9.4 AP912-102 64 pin LQFP package

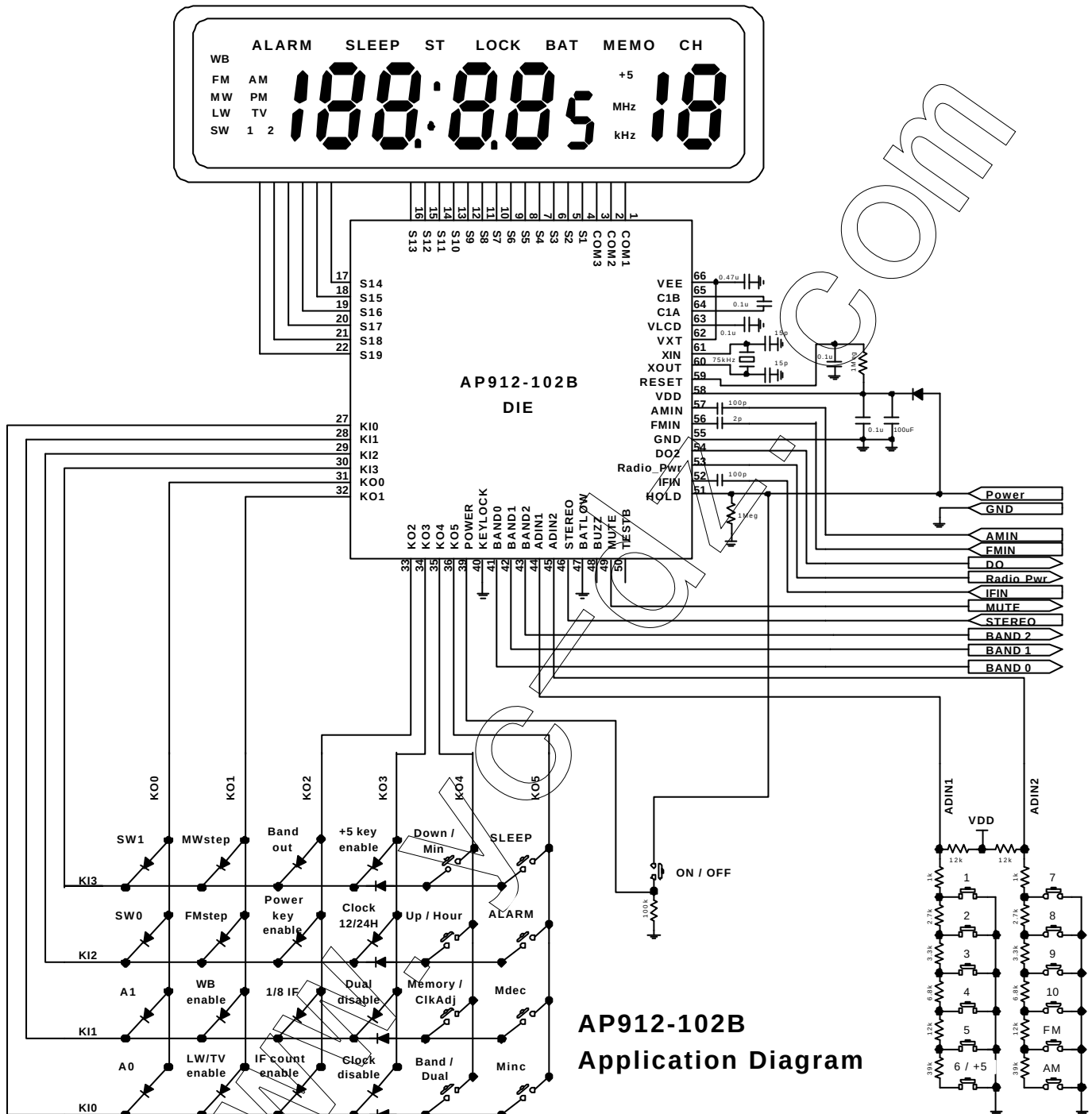


10 Application Diagram

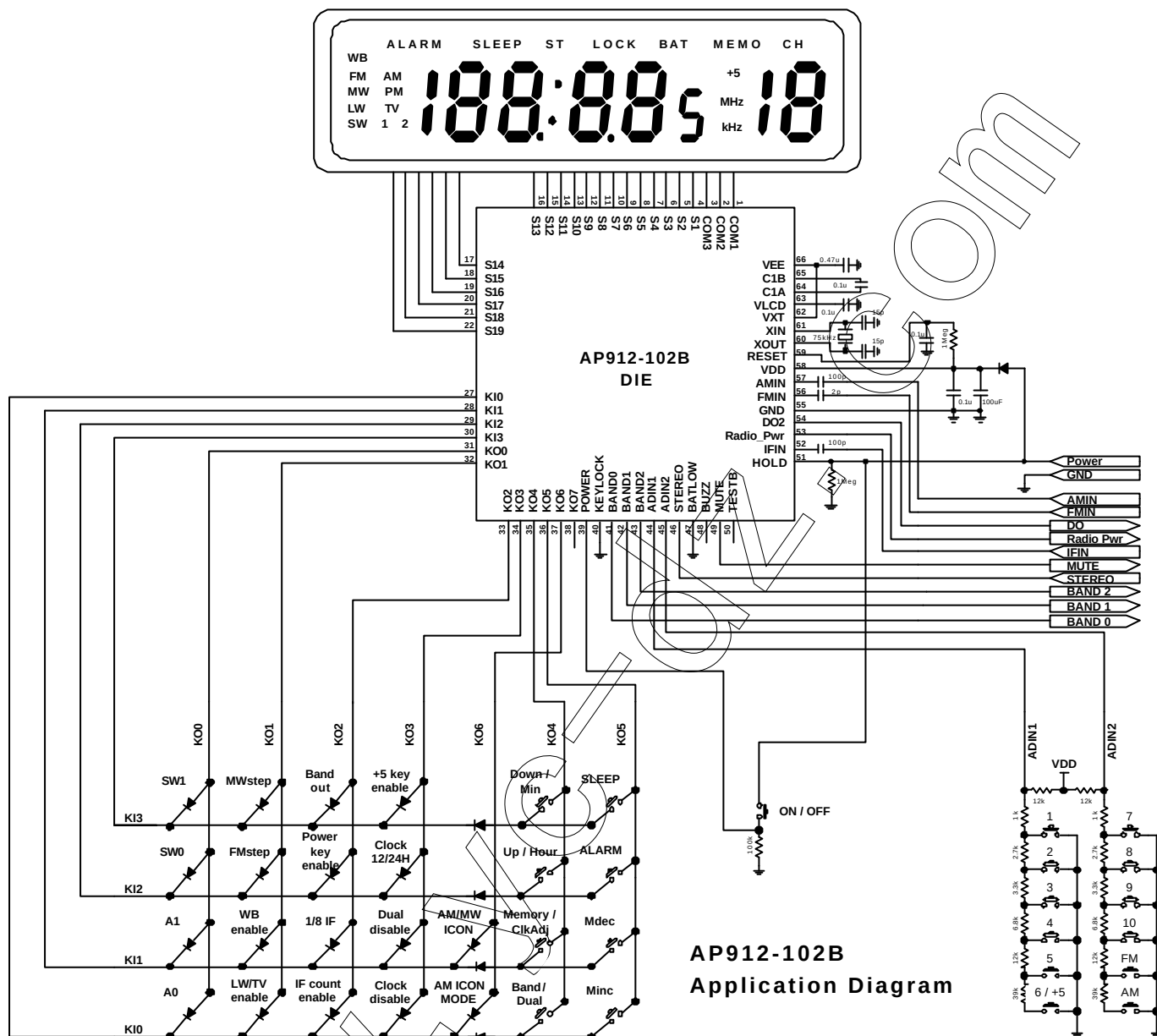
10.1 COB Application



10.2 DIE Application example 1



10.3 DIE Application example 2



2 extra jumper for setting AM ICON Display:

AM ICON MODE: 0 – Display AM/MW ICON similar to TC9318-033
1 – Display AM/MW ICON According to jumper AM/MW icon

AM/MW ICON: Used only when the AM ICON MODE Jumper present
0 – Display AM ICON when receiving AM/MW band
1 – Display MW ICON when receiving AM/MW band