

AP912 - 102

DTS Controller for Portable Radio

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1. OVERVIEW

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

The **AP912-102** also supports real time clock with 12/24 hour display format, alarm clock timer and dual clock.

By using advanced CMOS technology, **AP912-102** consumers very low power in clock mode.

3. APPLICATIONS

- Discman
- Boom Box
- Combo
- Portable Radio

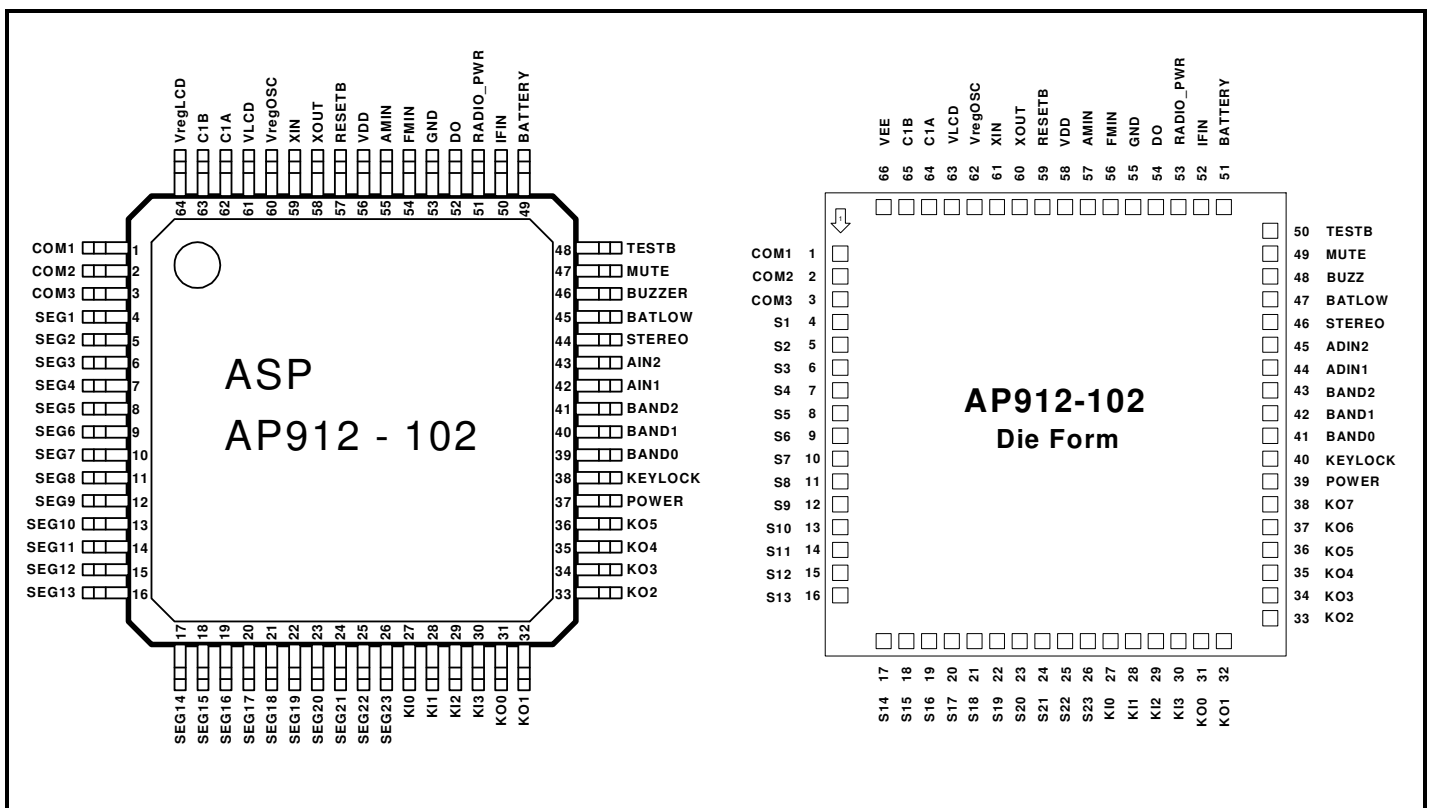
2. FEATURES

- 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

4. ORDERING INFORMATION

PART NUMBER	PINS	PACKAGE
AP912-102-LQ-L	64	LQFP-64
AP912-102-DC-L	66	Dice Form

5. PIN CONFIGURATION



6. BLOCK DIAGRAM

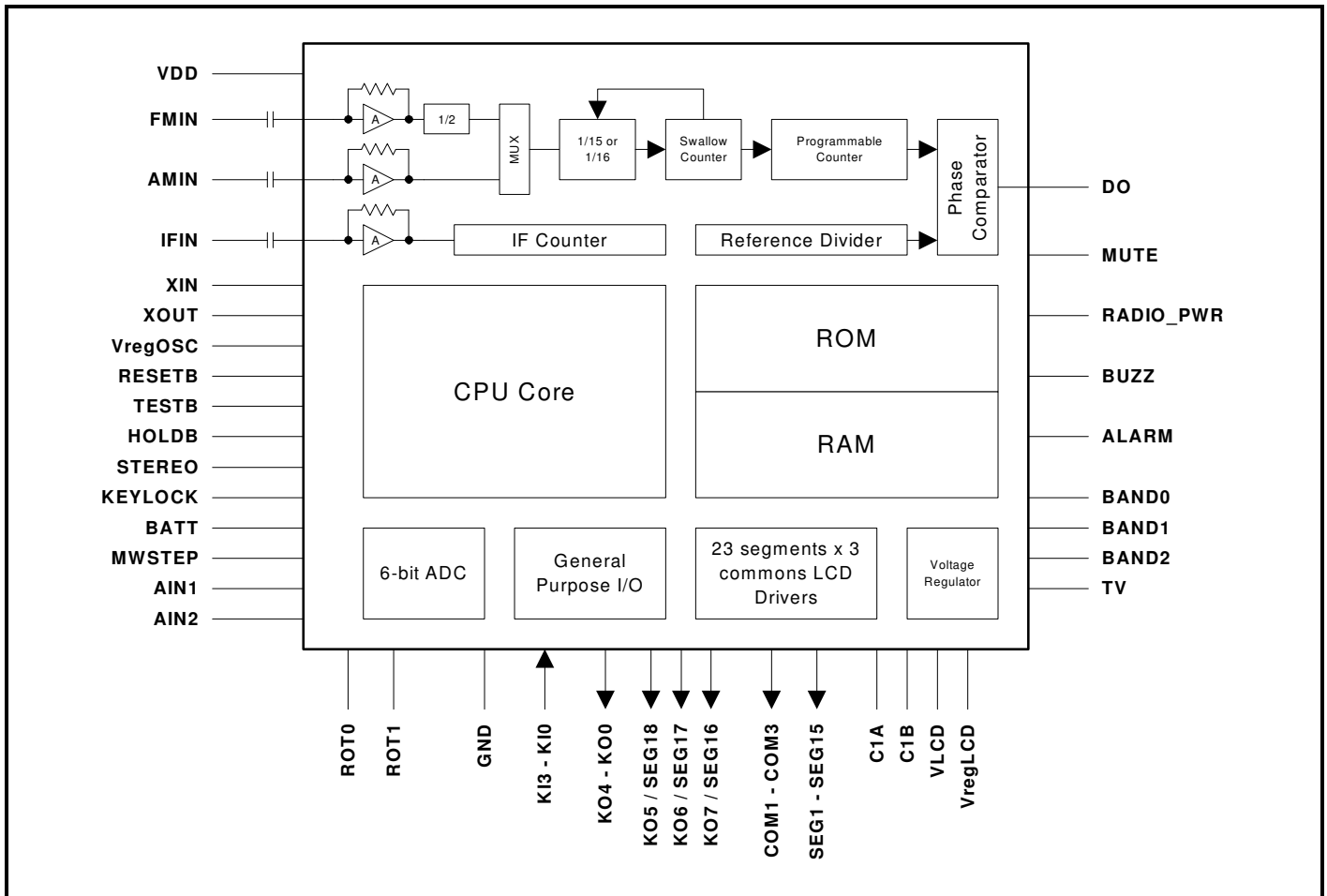


Figure 3. AP912-102 Block Diagram

7. DEVICE PIN DESCRIPTION

Pad #	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

Pad #	Package Pin #	Name	Type	Description
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	-	KO6	O	Keyboard scan output
38	-	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 in Section 8.5
42	40	BAND1	O	Refer to band switching table in Section 8.5
43	41	BAND2	O	Refer to band switching table in Section 8.5
44	42	AIN1	IA	Direct memory keys input pin
45	43	AIN2	IA	Direct memory keys input pin
46	44	STEREO	I	Stereo reception indication "0" - MONO mode "1" - STEREO Mode, stereo icon will lit up
47	45	BATLOW	I	Low battery input "0" - BATT indicator will flash "1" - BATT indicator will be 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
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	-	Ground
56	54	FMIN	IA	FM VCO signal input
57	55	AMIN	IA	AM VCO signal input
58	56	VDD	-	Power Supply
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	Internal Voltage double capacitor connection pin
65	63	C1B	A	Internal Voltage double capacitor connection pin
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
 POSC - Oscillator pad

8. FUNCTIONAL DESCRIPTION

8.1 Keyboard Layout

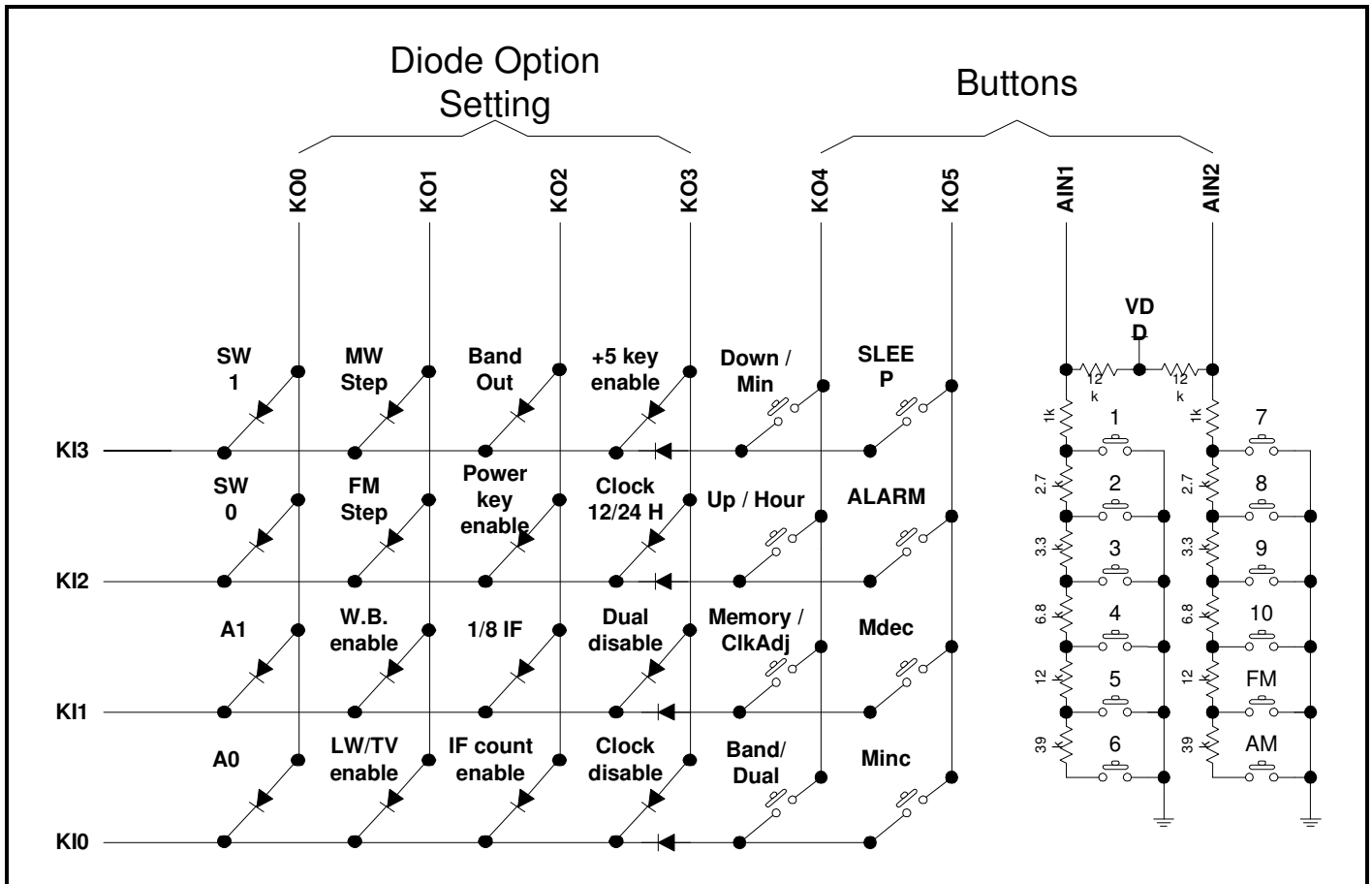


Figure 4. Keyboard Layout

8.2 Diode Option Matrix

The matrix formed by K10, K11, K12, K13 and KO0, KO1, KO2, KO3 are used to configure the AP912-102 operation. (with diode – “1”, without diode – “0”)

8.2.1 Operation region option (A0, A1)

This option is used to select the operating region of the chip.

A1	A0	Region
Without diode	Without diode	U.S.A.
Without diode	With diode	General
With diode	Without diode	Europe/ E-Europe
With diode	With diode	Japan

8.2.2 SW Band (level count) option (SW0, SW1)

This option is used to select the SW band for operation.

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

8.2.3 MW Step option (MW Step)

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

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

8.2.4 FM Step selection option (FMSTEP)

This option is used for the selection of the FM band step size.

U.S.A

FM step	Step	FM Receiving Frequency
Without diode	200kHz	87.5 ~ 108.0MHz
With diode	50kHz	87.5 ~ 108.0MHz

General

FM step	Step	FM Receiving Frequency
Without diode	100kHz	87.5 ~ 108.0MHz
With diode	50kHz	87.5 ~ 108.0MHz

Europe

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 (Step = 100kHz)

FM Step	LW/TV Enable	FM Receiving Frequency	TV Receiving Frequency
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

8.2.5 Weather band (WB) option (W.B. enable)

Configuration options for the weather band function

Weather Band Enable	Description
With diode	WB Enable
Without diode	WB Disable

8.2.6 LW/TV band option (LW/TV enable)

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

LW/TV Enable	TV Band	LW Band
With diode	Enable (Japan, U.S.A.)	Enable (Other)
Without diode	Disable (Japan, U.S.A.)	Disable (Other)

8.2.7 Band out option (Band Out)

This option is used to select band in or band out.

Band Out	Description
With diode	Band out
Without diode	Band in

8.2.8 Power key option (Power key enable)

This option is used to select the type of power switch.

Slide Switch	Functional mode
Without diode	Slide switch
With diode	TACT switch

8.2.9 FM IF Frequency option (1/8 IF)

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

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

8.2.10 Level count option (IF count enable)

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

IF Count Enable	Description
With diode	Enable IF frequency counting
Without diode	Use signal level detection for tuning indication

8.2.11 +5 Key option (+5 key enable)

This option is used to enable or disable the +5 Key feature.

+5 Key Enable	Description
With diode	+5 Key enable
Without diode	+5 Key disable

8.2.12 12 Hour / 24 Hour option (Clock 12/24 H)

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

12H / 24H	Clock Display Mode
Without diode	12 hour
With diode	24 hour

8.2.13 Dual clock option (Dual disable)

This option is used to enable or disable for the dual clock function.

Dual Clock Enable	Description
Without diode	Dual clock enable
With diode	Dual clock disable

8.2.14 Clock selection option (Clock disable)

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

CLOCK Disable	Real Time Clock
Without diode	Enable clock
With diode	Disable clock

8.3 Key Buttons

Name	Type	Description
Down / Min	Button	1. Tune down the station frequency when radio is on 2. Adjust the minute time when radio is off and clock adjust is enabled
Up / Hour	Button	1. Tune up the station frequency when radio is on 2. Adjust the hour time when radio is off and clock adjust is enabled
Mdec	Button	Decrement button
Minc	Button	Increment button
Memory / ClkAdj	Button	Memory selection or clock adjustment button
BAND / DUAL	Button	1. Radio frequency band selection when radio is on 2. In clock mode, two clocks are 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 was 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

8.4 LCD Layout

8.4.1 Recommended LCD plate (19 Segments, 3 Commons)

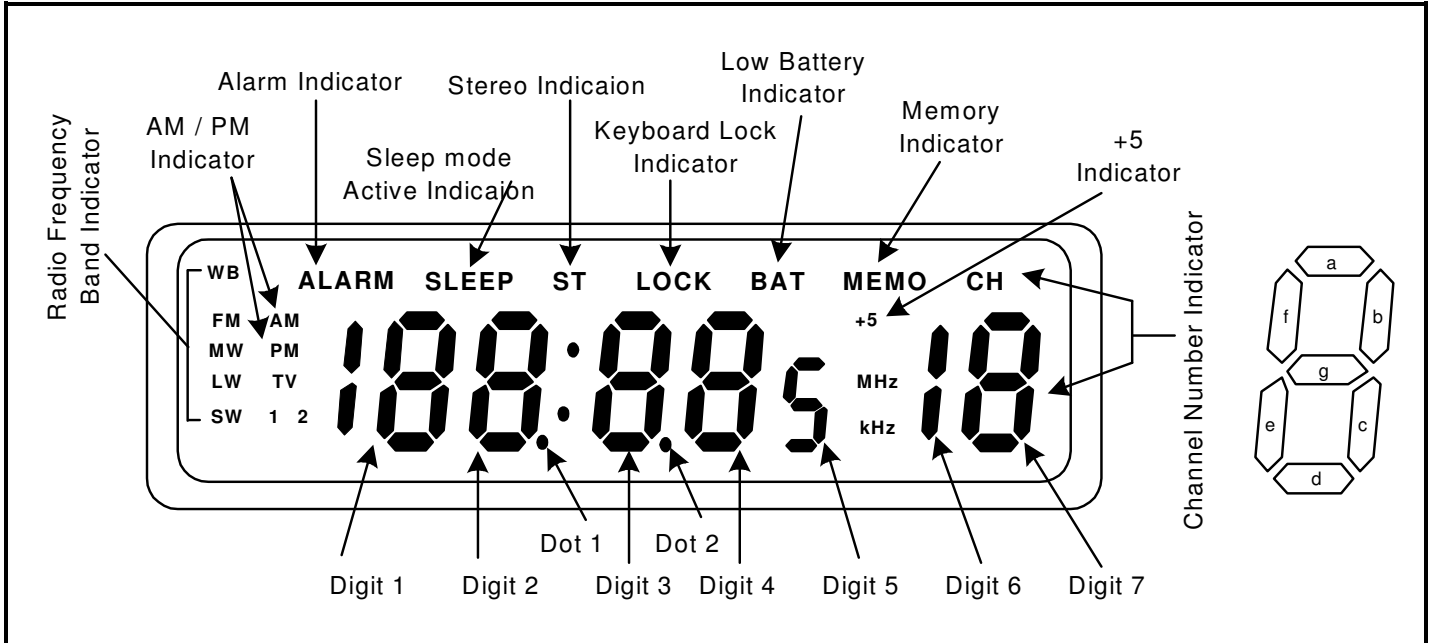


Figure 5. Recommended LCD Plate

	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	---

8.4.2 Frequency of receiving band

REGION	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 / E 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			

Note

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

*2. The frequency range of FM in Europe follows the value of the configuration of 'FM step' jumper.

*3. The frequency range of FM in Japan follows the value of the configuration of 'FM step' and 'LW/TV enable' jumper.

8.5 Band Switching Table

"BAND OUT" (diode option) is selected

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

“BAND IN” (diode option) is selected.

- With [LW/TV enable] diode jumper

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

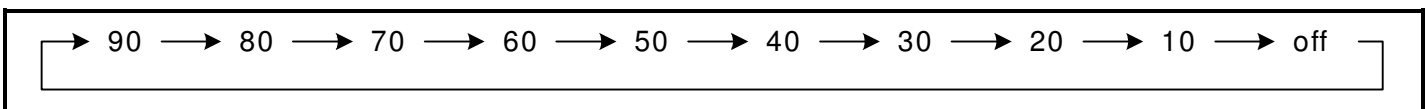
EUR/GEN	Pin	Band2	Band1	Band0
	I/O	OUT	IN	IN
	Function	TV OUT	B1	B0
	FM	L	L	L
	SW	L	H	H
	MW	L	L	H
	LW	L	H	L

- Without [LW/TV enable] diode jumper

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

8.6 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 displaying period, the sleep time can be changed by pressing the SLEEP button. Each time, if the SLEEP button is being pressed, the SLEEP time will be changed according to the following sequence:



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 has elapsed. After the sleep mode is cleared, **AP912-102** will disable the power down control for the radio.

9. ELECTRICAL SPECIFICATION

9.1 Absolute Maximum Ratings

Under no circumstances the absolute maximum ratings given below should be violated. Stresses exceeding one or more of the limiting values may cause permanent damage to the device.

PARAMETER	Symbol	Rating	Unit
Power supply voltage (logic)	V_{DD}	-0.5 to 7.0	V
Input voltage	V_{in}	-0.5 to $V_{DD}+0.5$	V
Power dissipation ($T_a = 70^\circ\text{C}$)	P_d	100	mW
Storage temperature	T_{stg}	-50 to 125	$^\circ\text{C}$
Operating temperature	T_{opr}	-20 to 70	$^\circ\text{C}$

9.2 Recommended Operating Condition

PARAMETER	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V_{DD}	1.8	-	3.3	V
Input voltage	V_{in}	0	-	VDD	V
Operating temperature	T_{opr}	-20	-	70	$^\circ\text{C}$

9.3 Electrical Characteristics

(VDD=3.0V unless otherwise specified)

Parameter	Condition	Symbol	Min.	Typ.	Max.	Unit
Supply voltage		V_{DD}	1.8	-	3.3	V
Current consumption Standby, no clock display	PLL off, oscillator off	I_{DD1}		<1		μA
Current consumption Standby with clock display	PLL off, oscillator on	I_{DD2}		60		μA
Current consumption – FM tuning	PLL on	I_{DD3}		6		mA
Current consumption – AM tuning	PLL on	I_{DD4}		5		mA
Input high voltage		V_{IH}	$0.8V_{DD}$	-	-	V
Input low voltage		V_{IL}	-	-	$0.2V_{DD}$	V
Pull-up resistance	$V_{IN} = 0\text{V}$	R_{PU}	100	-	-	$\text{k}\Omega$
Pull-down resistance	$V_{IN} = V_{DD}$	R_{PD}	100	-	-	$\text{k}\Omega$
FMIN, AMIN and IFIN input voltage		V_{ina}	300		-	mV(pp)
Output low current for RADIO_PWR pin	$V_{OL} = 0.4\text{V}$	I_{OL1}	-	1	-	mA
Output low current for MUTE, BUZZER	$V_{OL} = 0.4\text{V}$	I_{OL2}	-	1	-	mA
Output high current for K0 – K5	$V_{OH} = V_{DD} - 0.4\text{V}$	I_{OH1}	-	1	-	μA

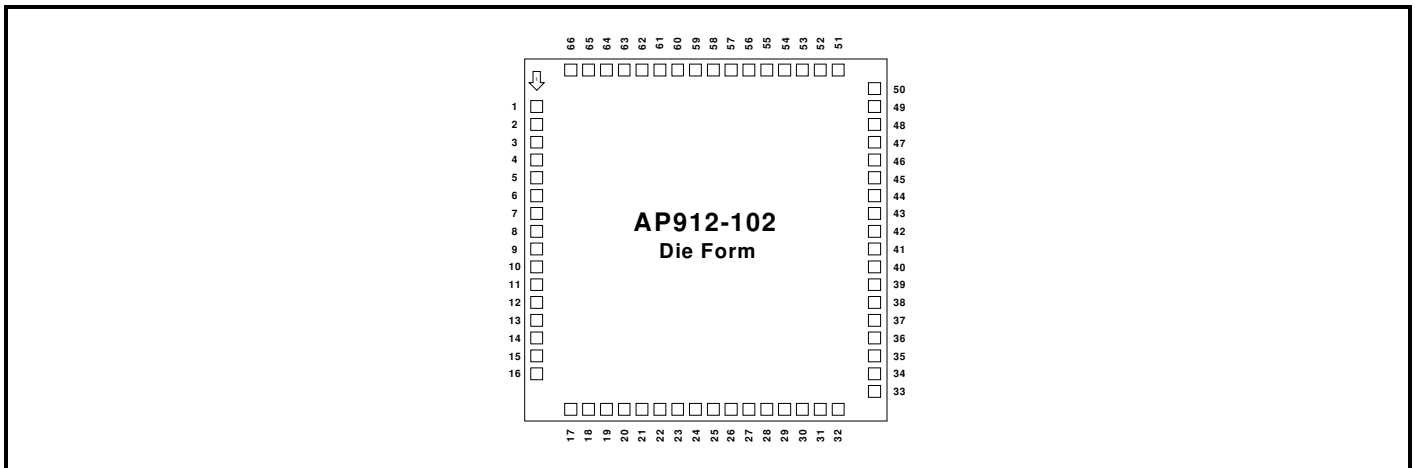
10. BONDING AND PACKAGE INFORMATION

10.1 Bonding Information

AP912-102 bonding pad center coordinates and pin assignment

- Die Size : 2510 x 2510 μm^2 (Excluding Scribe Line)
- Origin : Lower left hand corner
- Minimum Pad Pitch : 110 μm
- Pad Opening : 90 x 90 μm^2

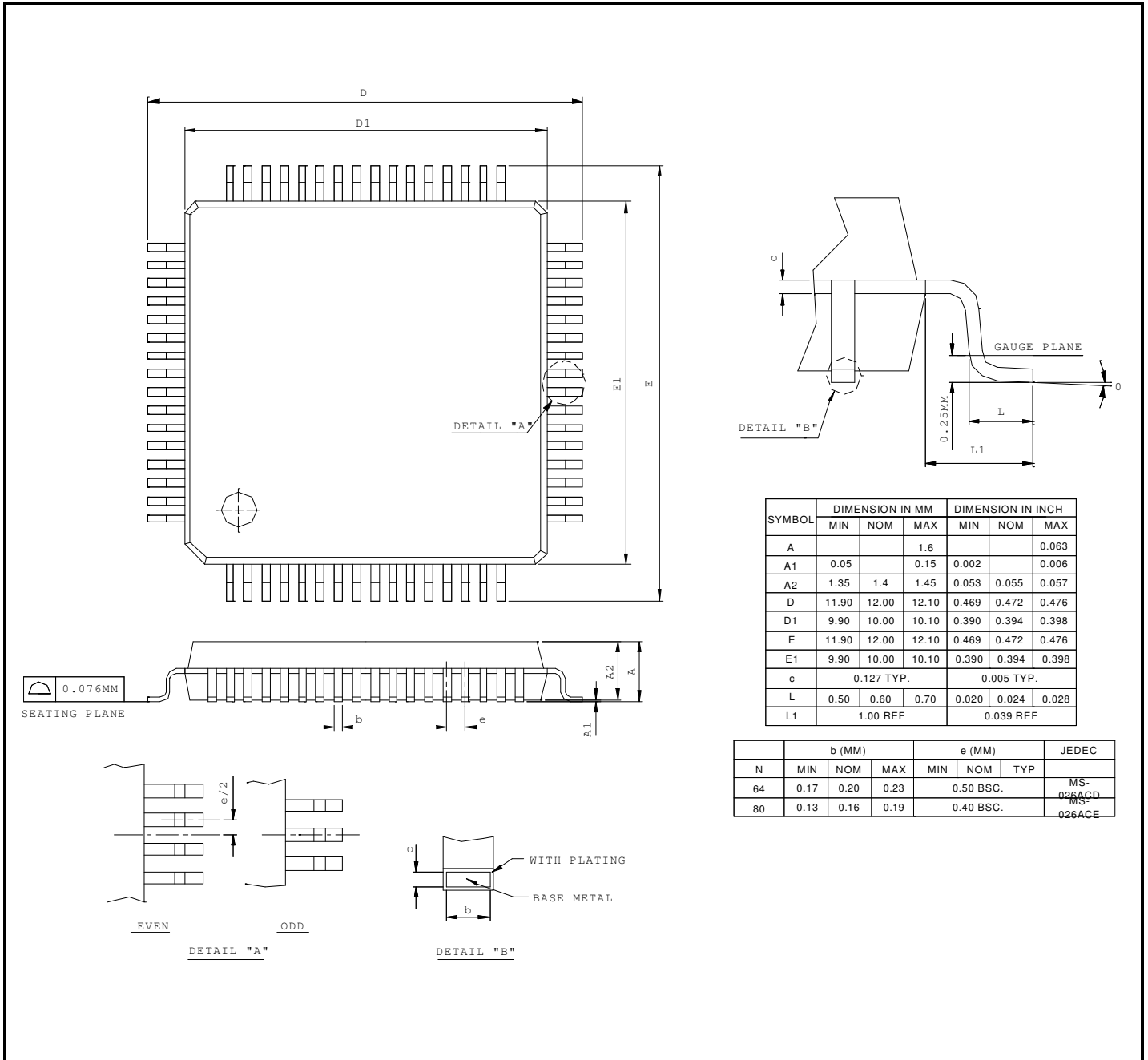
Note : Substrate has to be connected to Ground



PAD #	PAD NAME	X-coordinate (μm)	Y-coordinate (μm)	PAD #	PAD NAME	X-coordinate (μm)	Y-coordinate (μm)
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

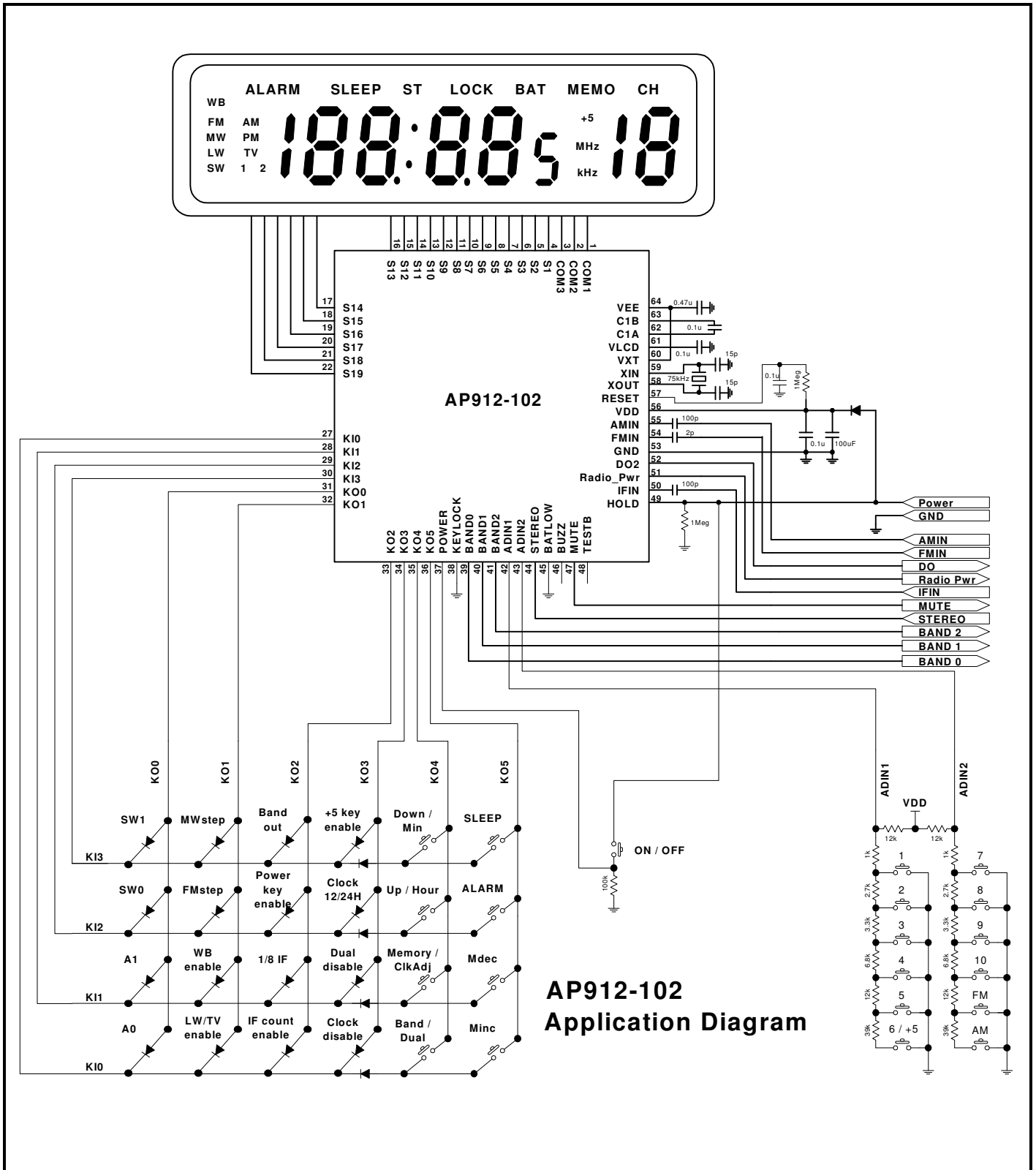
10.2 Package Information

64 pin LQFP package

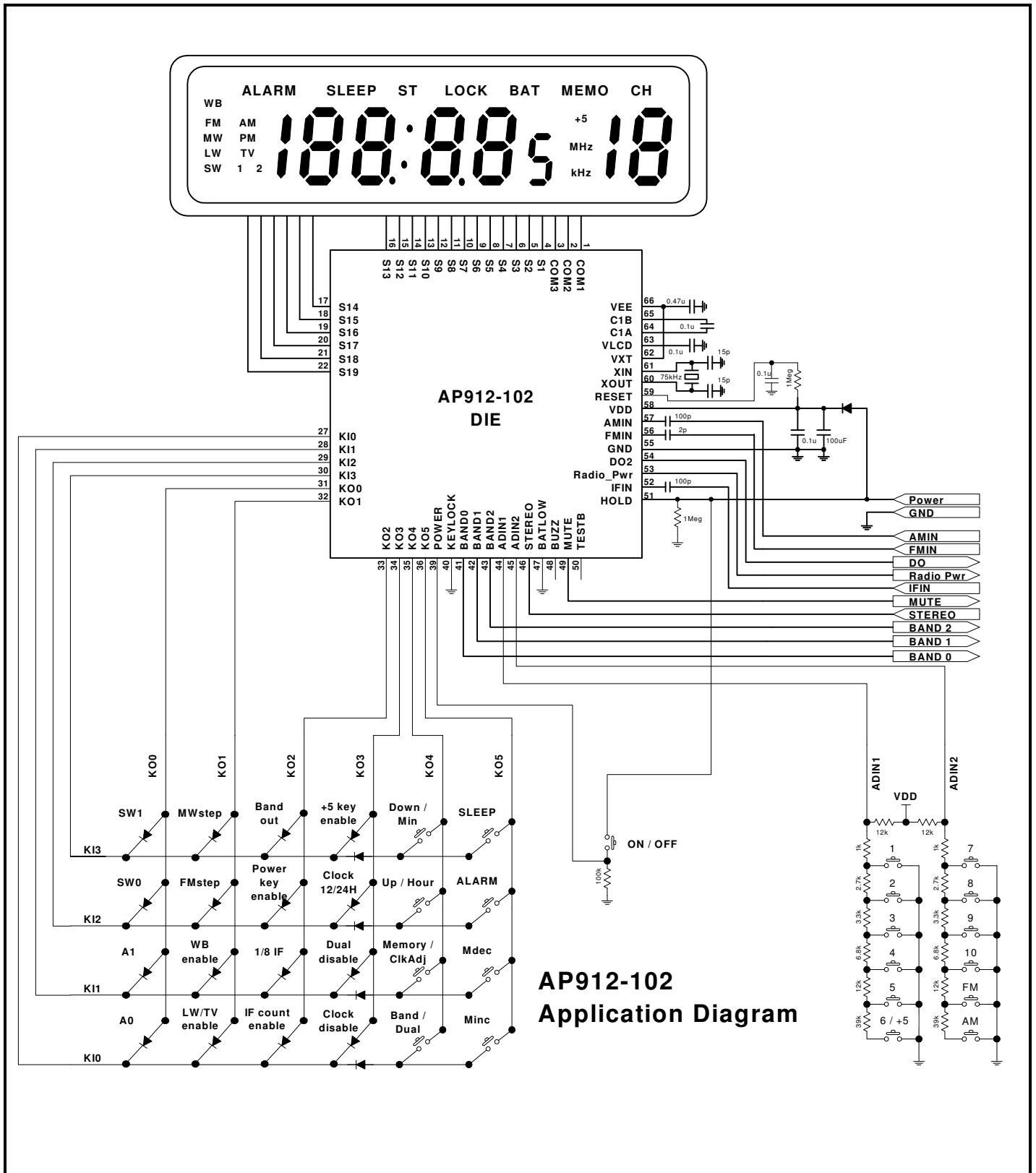


11. TYPICAL APPLICATION

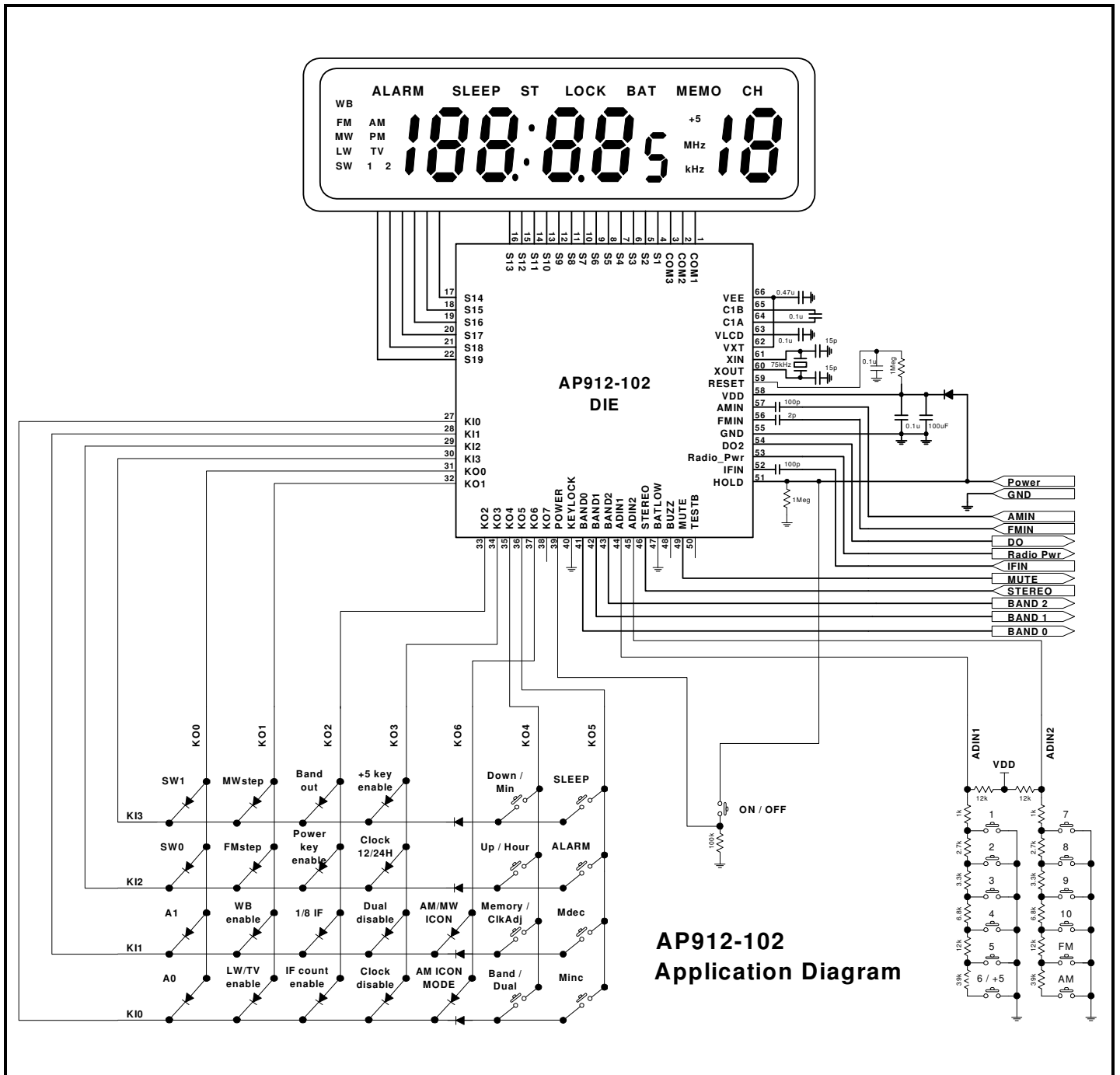
11.1 LQFP Application Circuit



11.2 Die Application Example 1



11.3 Die Application Example 2



There are 2 extra jumpers 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 (use only when the AM ICON MODE Jumper is present)

- 0 – Display AM ICON when receiving AM/MW band
- 1 – Display MW ICON when receiving AM/MW band



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