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RENESAS

Application Note

μPD78366A

16-/8-bit Single-chip Microcontroller

Inverter control

μPD78361A
μPD78362A
μPD78P364A
μPD78363A
μPD78365A
μPD78366A
μPD78368A
μPD78P368A

Document No. U12234EJ1V0AN00 (1st edition)
Date Published July 1997 J

SUMMARY OF CONTENTS

Phase-out/Discontinued

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- Device availability
- Ordering information
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- Availability of related technical literature
- Development environment specifications (for example, specifications for third-party tools and components, host computers, power plugs, AC supply voltages, and so forth)
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PREFACE

Intended Readership

This application note is aimed at engineers who wish to familiarize themselves with the functions of the μPD78366A sub-series products, and design application programs using these products.

- μPD78366A sub-series: μPD78361A, μPD78362A, μPD78P364A, μPD78363A, μPD78365A, μPD78366A, μPD78368A, and μPD78P368A

Purpose

The purpose of this application note is to help users understand the inverter control functions of the μPD78366A sub-series products, by using a sample application.
The program and hardware configurations published here are just examples and are not intended for mass production.

Organization

This application note is divided into the following sections:

- Overview of functions
- Hardware configuration
- Control
- Cautions
- Flowcharts
- Program list

Legend

In this application note, symbols and notation are used as follows:

Weighting in data representation:	Most significant digit at the left, least significant digit at the right
Representation of active-low:	$\overline{xxx}$ (overscore above a pin or signal name)
Note:	Explanation of a note in text
Caution:	Information requiring special attention
Remark:	Supplementary explanation of text
Number representation:	Binary: xxxxxxxxB Decimal: xxxx Hexadecimal: xxxxH
Characters that are easily confused:	0 (zero), O (uppercase of o) 1 (one), l (lowercase of L), I (uppercase of i)

Related Documents

- **Device-related documents**

Document name	Document number	
	Japanese	English
μPD78362A Data Sheet	U10098J	U10098E
μPD78P364A Data Sheet	U10106J	U10106E
μPD78363A, 78365A, 78366A Data Sheet	U11109J	U11109E
μPD78P368A Data Sheet	U11373J	U11373E
μPD78362A User's Manual, Hardware	U10745J	U10745E
μPD78366A User's Manual, Hardware	U10205J	U10205E
μPD78356 User's Manual, Instructions	IEU-853	IEU-1395
μPD78366A Application Note, Inverter Control	U12234J	This manual
μPD78362A Special Function Registers	U10201J	—
μPD78366A Special Function Registers	U10107J	—
μPD78352A Instruction Set	U11955J	—

- **Development tool-related documents**

Document name		Document number	
		Japanese	English
IE-78350-R User's Manual	Hardware	EEU-754	EEU-1356
	Software	EEU-753	EEU-1376
IE-78365-R-EM1 User's Manual		EEU-924	EEU-1454
EP-78327CW-R User's Manual		EEU-969	EEU-1496

Caution These related documents may be revised without notice. Be sure to use the latest edition of the documents when you design your system.

CONTENTS

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LIST OF TABLES

CHAPTER 1 OVERVIEW OF FUNCTIONS

As a sample application for the real-time pulse unit (RPU) of the μPD78366A, this chapter introduces an application for three-phase inverter control according to PWM output.

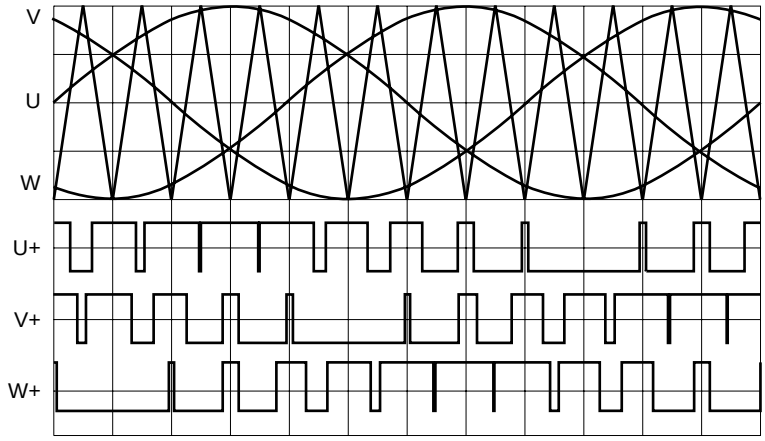
The operating environment is shown below.

CPU:	μPD78366A
Operating clock:	System clock 8 MHz (Internal: 16 MHz)
Operating voltage:	5 V
Internal ROM:	32K bytes
Internal RAM:	2K bytes
Extended memory:	None installed (supported)

1.1 PWM SIGNAL GENERATION

As shown in Figure 1-1, the PWM signal is generated by using a sawtooth (carrier) wave to modulate a sine wave.

Figure 1-1. Use of Sawtooth Wave to Generate PWM Sine Waveform

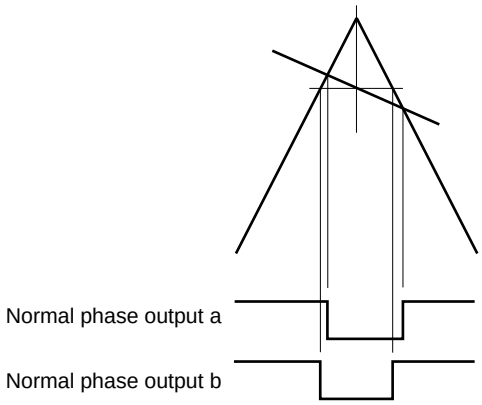


Remark The U-, V-, and W- phases are obtained by inverting the high and low levels of the waveforms of the U+, V+, and W+ phases.

Figure 1-2 shows the switching timing of the normal phase output.

When switching occurs at the intersection of the sawtooth and sine waves, a waveform like that indicated by a is generated. However, depending on the complexity of the processing and the number of settings, the sample application simulates switching at the timing indicated by b.

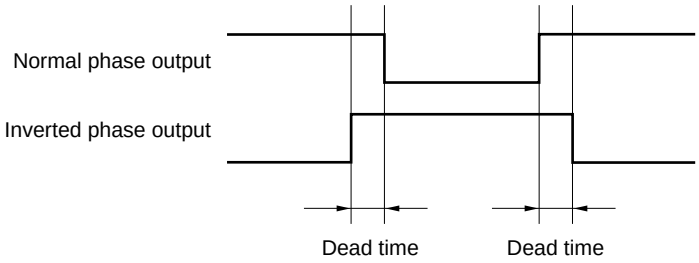
Figure 1-2. Switching Timing



1.2 DEAD TIME

To prevent the positive and negative transistors of each phase from going on together, dead time is inserted into the PWM output. The dead time can be set, by key input, to a value of between 5 μs and 50 μs, the output of the PWM signal being driven low after the elapse of the previously set delay.

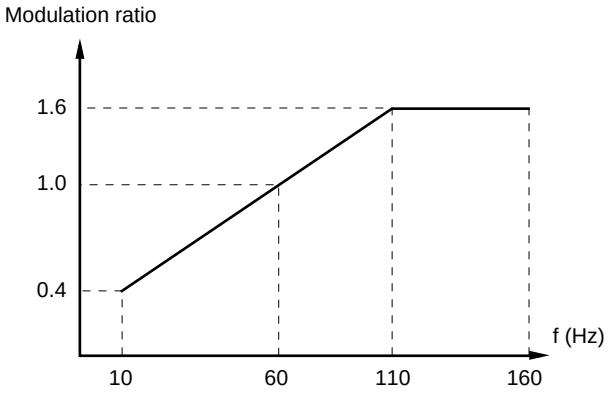
Figure 1-3. Dead Time



1.3 V/f CONTROL

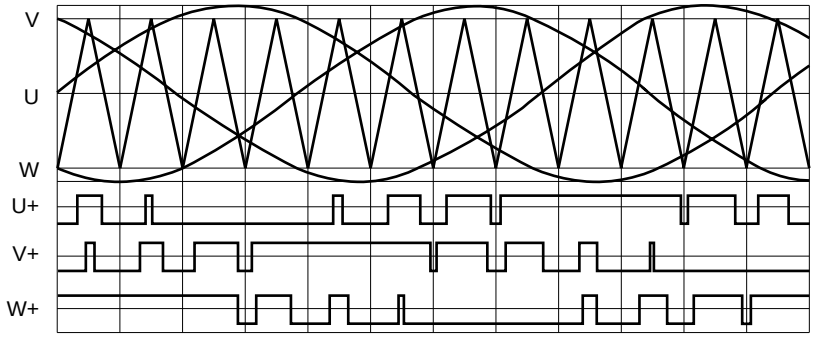
To adjust the torque of the motor, V/f control is used to adjust the voltage (V) in line with the output frequency (f). Figure 1-4 shows how the characteristic modulation ratio of the sample program varies with the output frequency. The modulation ratio (sine wave amplitude)/(sawtooth wave amplitude) is such that, when equal to 1, the sawtooth wave amplitude is equal to that of the sine wave.

Figure 1-4. Variation of Characteristic Modulation Ratio with Output Frequency



After V/f modulation, if the sawtooth and sine waves do not intersect, as shown in Figure 1-5, switching is not performed.

Figure 1-5. Generation of PWM Sine Waveform under V/f Control



Remark The U-, V-, and W- phases are obtained by inverting high- and low-level waveforms of the U+, V+, and W+ phases.

1.4 INVERTER OUTPUT SETTING RANGE

Table 1-1 indicates the inverter output setting range for the sample application.

Table 1-1. Inverter Output Setting Range

Carrier frequency (Hz)	Output frequency setting range (Hz)	Dead time setting range (μs)
200	4 to 25	5 to 50
400	4 to 50	
600	4 to 75	
800	4 to 100	
1000	4 to 120	
1200	4 to 160	
1400 to 8200		
8400 to 8800		5 to 48
9000 to 9200		5 to 46
9400 to 9600		5 to 44
9800 to 10200		5 to 42
10400 to 10800		5 to 40
11000 to 11400		5 to 38
11600 to 12000		5 to 36
12200 to 12800		5 to 34
13000 to 13800		5 to 32
14000 to 14800		5 to 30
15000 to 15800		5 to 28
16000 to 17200		5 to 26
17400 to 18600		5 to 24
18800 to 20000		5 to 22

1.5 FREQUENCY SHIFTING

The current frequency is compared with the set frequency (target frequency) every 5 ms.

When the current and target frequencies are found to differ, the output frequency is adjusted in 1 Hz steps, at the specified rate of change.

1.6 DIFFERENCE BETWEEN SYNCHRONOUS AND ASYNCHRONOUS OUTPUT

Upon a reset start, synchronous or asynchronous PWM output can be selected according to the input to pin 90 (set with JP2) (invalid at any time other than upon a reset start).

When synchronous output is selected, the value of the carrier frequency is adjusted to an integer multiple of the output frequency.

The differences between the processing performed for synchronous and asynchronous output are listed in Table 1-2.

Table 1-2. Differences between the Processing Performed for Synchronous and Asynchronous Output

Processing	Synchronous output	Asynchronous output
Carrier frequency setting	Adjusted to integer multiple of output frequency	As set
Sine wave data reference	Data is referenced based on the phase of the sine wave. The phase returns to 0 upon the completion of one sine wave cycle.	Data is referenced based on the phase of the sine wave. The phase does not return to 0 upon the completion of one sine wave cycle.
Timing at which output frequency change is started	After the output frequency change wait has passed, or upon the completion of one sine wave cycle	During the output frequency change wait

1.7 CHANGE PATTERN TABLE

When the motor starts or is accelerated, between the minimum output frequency (4 Hz) and the preset frequency, the carrier frequency and speed of frequency change are automatically changed as specified in the following table.

As listed in Table 1-3, ten change pattern settings exist in ROM. One is selected according to key input at a reset start.

The preset output frequency range, as determined by the change pattern, cannot be changed by key input.

Table 1-3. Change Pattern

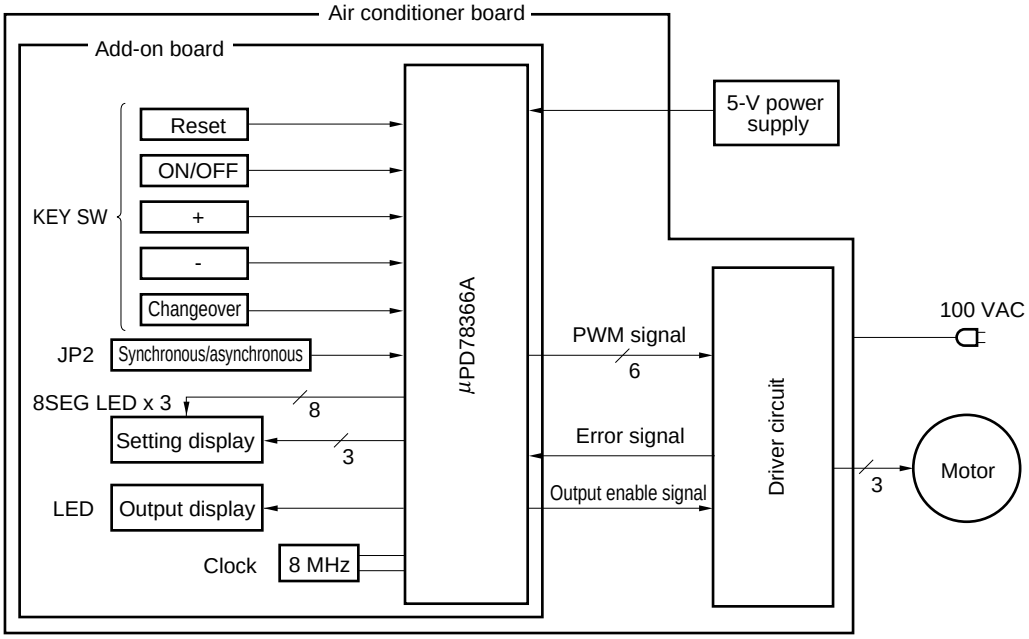
No.	Rate of frequency change	Carrier frequency setting
1	—	No change pattern (4 Hz to 160 Hz, set by key input)
2	0.5 Hz/s	Output [Hz]: 4 to 6 / 7 to 9 / 10 / 11 to 160 Carrier [Hz]: 200 / 400 / 600 / Set by key input
3	1.0 Hz/s	Output [Hz]: 4 to 6 / 7 to 9 / Every 3 Hz, / 16 to 18 / 19 to 20 / 21 to 160 Carrier [Hz]: 200 / 400 / increased by 200 Hz / 1000 / 1200 / Set by key input
4	2.0 Hz/s	Output [Hz]: 4 to 6 / 7 to 9 / Every 3 Hz, / 25 to 27 / 28 to 30 / 31 to 160 Carrier [Hz]: 200 / 400 / increased by 200 Hz / 1600 / 1800 / Set by key input
5	0.5 Hz/s	Output [Hz]: 4 / 5 / 6 / Every 1 Hz / 9 / 10 / 11 to 160 Carrier [Hz]: 200 / 400 / 600 / increased by 200 Hz / 1200 / 1400 / Set by key input
6	1.0 Hz/s	Output [Hz]: 4 / 5 / 6 / Every 1 Hz / 19 / 20 / 21 to 160 Carrier [Hz]: 200 / 400 / 600 / increased by 200 Hz / 3200 / 3400 / Set by key input
7	2.0 Hz/s	Output [Hz]: 4 / 5 / 6 / Every 1 Hz / 29 / 30 / 31 to 160 Carrier [Hz]: 200 / 400 / 600 / increased by 200 Hz / 5200 / 5400 / Set by key input
8	0.5 Hz/s	Output [Hz]: 4 / 5 / 6 / Every 1 Hz / 9 / 10 / 11 to 160 Carrier [Hz]: 400 / 800 / 1200 / increased by 400 Hz / 2400 / 2800 / Set by key input
9	1.0 Hz/s	Output [Hz]: 4 / 5 / 6 / Every 1 Hz / 19 / 20 / 21 to 160 Carrier [Hz]: 400 / 800 / 1200 / increased by 400 Hz / 6400 / 6800 / Set by key input
10	2.0 Hz/s	Output [Hz]: 4 / 5 / 6 / Every 1 Hz / 29 / 30 / 31 to 160 Carrier [Hz]: 400 / 800 / 1200 / increased by 400 Hz / 10400 / 10800 / Set by key input

CHAPTER 2 HARDWARE CONFIGURATION

2.1 SYSTEM CONFIGURATION

Figure 2-1 shows the hardware configuration.

Figure 2-1. Hardware Configuration

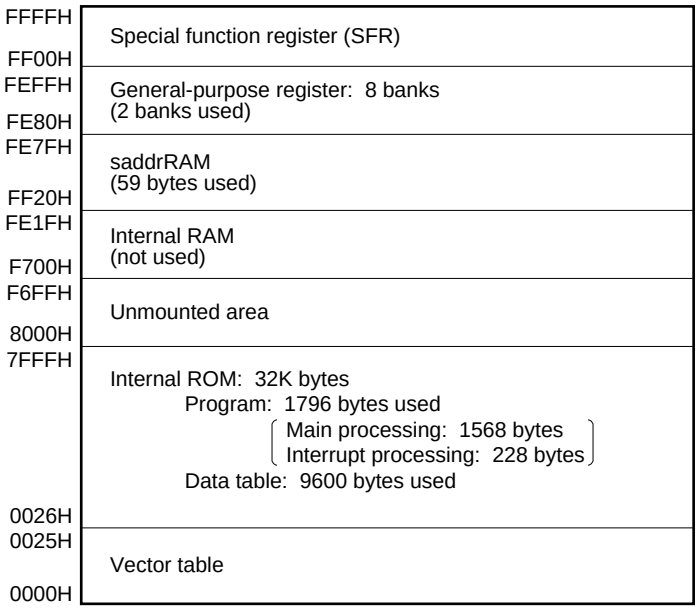


2.2 CPU BLOCK

2.2.1 Memory Map

Figure 2-2 shows the memory map.

Figure 2-2. Memory Map



2.2.2 Pin Mapping

Table 2-1. Pin Mapping (1/3)

No.	Pin name	I/O	Signal name	A	R	Setting
1	V_{SS}	—	Ground	—	—	—
2	P00	I/O	Enable signal output	L	I	H
3	P01	I/O	Not used (connected to V_{SS})	—	I	I
4	P02	I/O		—	I	I
5	P03	I/O		—	I	I
6	P04	I/O		—	I	I
7	P05	I/O		—	I	I
8	P06	I/O		—	I	I
9	P07	I/O	Dead time output	—	I	L
10	$\overline{WDTO}$	O	Open	—	O	—
11	IC	—	(Connected to V_{SS})	—	I	—
12	V_{DD}	—	Power supply	—	—	—
13	V_{SS}	—	Ground	—	—	—
14	X1	I	System clock	—	I	—
15	X2	—	System clock	—	—	—
16	MODE1	I	(Connected to V_{SS})	—	I	—
17	$\overline{RESET}$	I	[RESET] input	L	I	I
18	P30	I/O	Not used (connected to V_{SS})	—	I	I
19	P31	I/O		—	I	I
20	P32	I/O		—	I	I
21	P33	I/O		—	I	I
22	P34	I/O		—	I	I
23	P35	I/O		—	I	I
24	P36	I/O		—	I	I
25	P10	I/O		—	I	I
26	P11	I/O		—	I	I
27	P12	I/O		—	I	I
28	P13	I/O		—	I	I
29	P14	I/O		—	I	I
30	P15	I/O		—	I	I
31	P16	I/O		—	I	I
32	P17	I/O		—	I	I

Remark I/O: Input/output (I: Input, O: Output)
A: Active level (H: High level, L: Low level)
R: Pin status at reset (I: Input, O: Output)
Setting: Setting made at initialization (I: Input, H: High-level output, L: Low-level output)

Table 2-1. Pin Mapping (2/3)

No.	Pin name	I/O	Signal name	A	R	Setting
33	V_{SS}	—	Ground	—	—	—
34	MODE0	I	(Connected to V_{SS})	—	—	—
35	NMI	I	Error signal input	L	I	I
36	P21	I	Not used (connected to V_{SS})	—	I	I
37	P22	I		—	I	I
38	P23	I		—	I	I
39	P24	I		—	I	I
40	P25	I		—	I	I
41	AV_{SS}	I		—	I	—
42	P70	I		—	I	I
43	P71	I		—	I	I
44	P72	I		—	I	I
45	P73	I		—	I	I
46	P74	I		—	I	I
47	P75	I		—	I	I
48	P76	I		—	I	I
49	P77	I		—	I	I
50	AV_{REF}	I	Not used (connected to V_{DD})	—	I	—
51	AV_{DD}	—		—	I	—
52	V_{DD}	—	Power supply	—	—	—
53	V_{SS}	—	Ground	—	—	—
54	P40	I/O	SEG LED(a) output	H	I	L
55	P41	I/O	SEG LED(b) output	H	I	L
56	P42	I/O	SEG LED(c) output	H	I	L
57	P43	I/O	SEG LED(h) output	H	I	L
58	P44	I/O	SEG LED(d) output	H	I	L
59	P45	I/O	SEG LED(e) output	H	I	L
60	P46	I/O	SEG LED(g) output	H	I	L
61	P47	I/O	SEG LED(f) output	H	I	L
62	P50	I/O	SEG LED digit 1 output	H	I	L
63	P51	I/O	SEG LED digit 2 output	H	I	L
64	P52	I/O	SEG LED digit 3 output	H	I	L
65	P53	I/O	Operation indicator LED	H	I	L

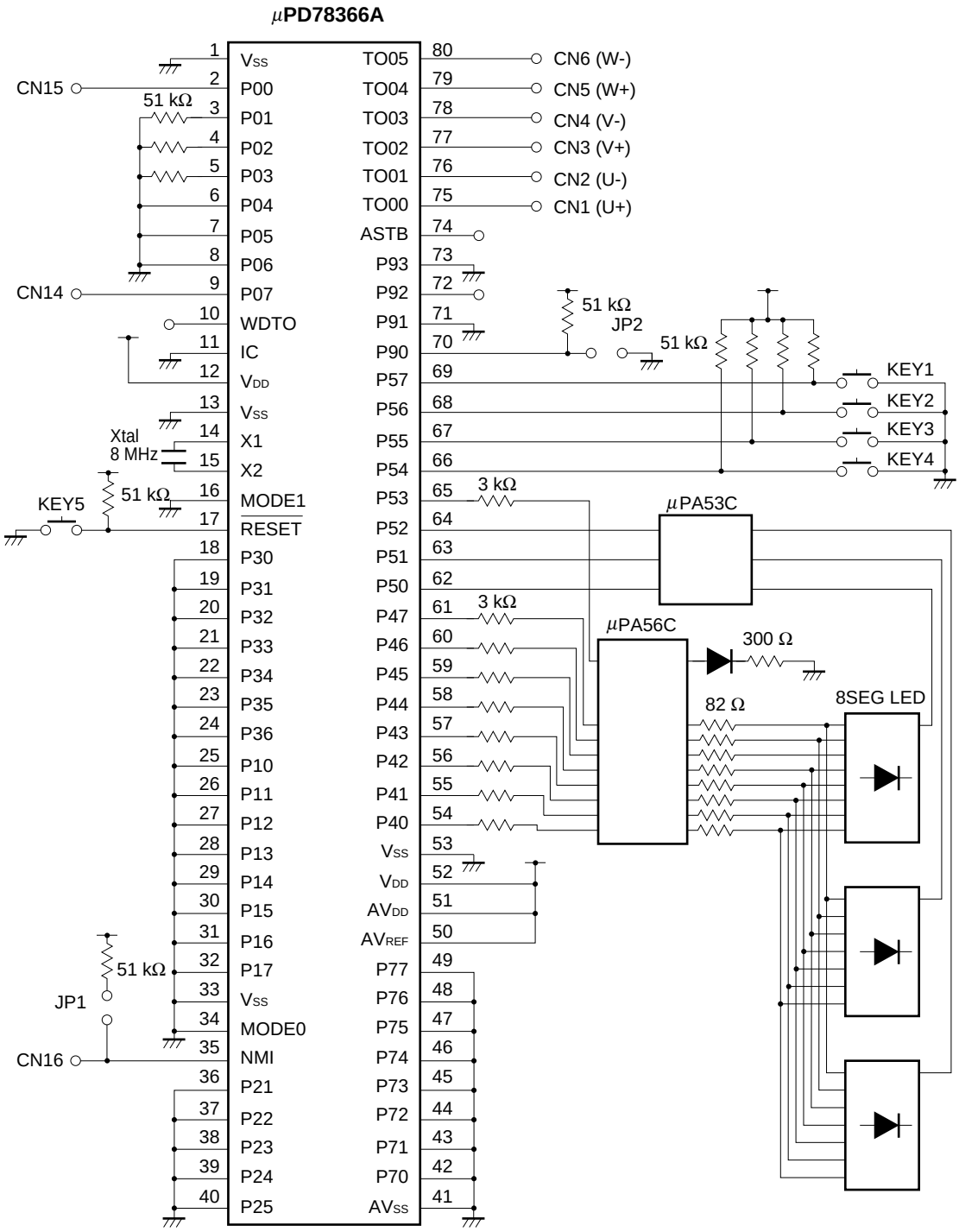
Remark I/O: Input/output (I: Input, O: Output)
A: Active level (H: High level, L: Low level)
R: Pin status at reset (I: Input, O: Output)
Setting: Setting made at initialization (I: Input, H: High-level output, L: Low-level output)

Table 2-1. Pin Mapping (3/3)

No.	Pin name	I/O	Signal name	A	R	Setting
66	P54	I/O	[ON/OFF] input	L	I	I
67	P55	I/O	[+] input	L	I	I
68	P56	I/O	[-] input	L	I	I
69	P57	I/O	[changeover] input	L	I	I
70	P90	I/O	Synchronous/asynchronous	—	I	I
71	P91	I/O	Not used (V_{SS})	—	I	I
72	P92	I/O	Not used (open)	—	I	L
73	P93	I/O	Not used (V_{SS})	—	I	I
74	ASTB	O	Open	—	—	—
75	TO00	I/O	U+ output	L	I	H
76	TO01	I/O	U- output	L	I	H
77	TO02	I/O	V+ output	L	I	H
78	TO03	I/O	V- output	L	I	H
79	TO04	I/O	W+ output	L	I	H
80	TO05	I/O	W- output	L	I	H

Remark I/O: Input/output (I: Input, O: Output)
A: Active level (H: High level, L: Low level)
R: Pin status at reset (I: Input, O: Output)
Setting: Setting made at initialization (I: Input, H: High-level output, L: Low-level output)

2.3 CIRCUIT DIAGRAM



CHAPTER 3 CONTROL

3.1 STATE TRANSITION TABLE

Table 3-1 lists the state transitions. During the execution of the mode handling indicated by **<1>** to **<5>** under "State," if any of the events indicated under "Factor" should occur, transition to the mode having the number shown is performed.

A " — " in a column indicates that mode transition is not performed. Input is valid, however.

A " — " in a column indicates that input is not valid.

Table 3-1. State Transition

State[Note 1] \ Factor[Note 2]		Reset input	ON/OFF input	+ input	- input	Changeover input	Stop signal	Synchronous/ asynchronous input	Processing end
<1>	Initialize	—	—	—	—	—	—	—	**<5>**
<2>	Output frequency change	**<1>**	**<5>**	**<4>**	**<4>**	—	**<5>**	—	**<3>**
<3>	Fixed output frequency	**<1>**	**<5>**	**<4>**	**<4>**	—	**<5>**	—	—
<4>	Setting	**<1>**	**#1**	—	—	**#1**	**<5>**	—	—
<5>	Signal output stop	**<1>**	**#2**	**<4>**	**<4>**	—	—	—	—

#1: Transition to mode **<2>**, **<3>**, or **<5>** is performed depending on the output state.

#2: Transition to mode **<2>** is performed when no stop signal is input.

Notes 1. States

Initialize: Initially set processing state, set immediately after a reset start.

Output frequency change: Frequency change processing state, set when the target frequency differs from the output frequency.

Fixed frequency output: Fixed frequency output state, set when the target frequency matches the output frequency.

Setting: Setting of change pattern to be selected by key input, target frequency, carrier frequency, dead time, and rate of frequency change.

Signal output stop: State existing when signal output is stopped.

2. Factors

Reset input: When key switch connected to reset pin is pressed

ON/OFF input: When [ON/OFF] key is pressed

+ input: When [+] key is pressed

- input: When [-] key is pressed

Changeover input: When [changeover] key is pressed

Stop signal: When input of the stop signal is detected

Synchronous/asynchronous input: When selection of synchronous or asynchronous operation is performed

Processing end: When initialization ends, and transition to the signal output stopped state is performed. Or, when output frequency change processing ends, and transition to fixed frequency output is performed

3.2 PROGRAM COMPOSITION

Table 3-2 outlines the constituent subroutines and interrupt processing performed by the sample application.

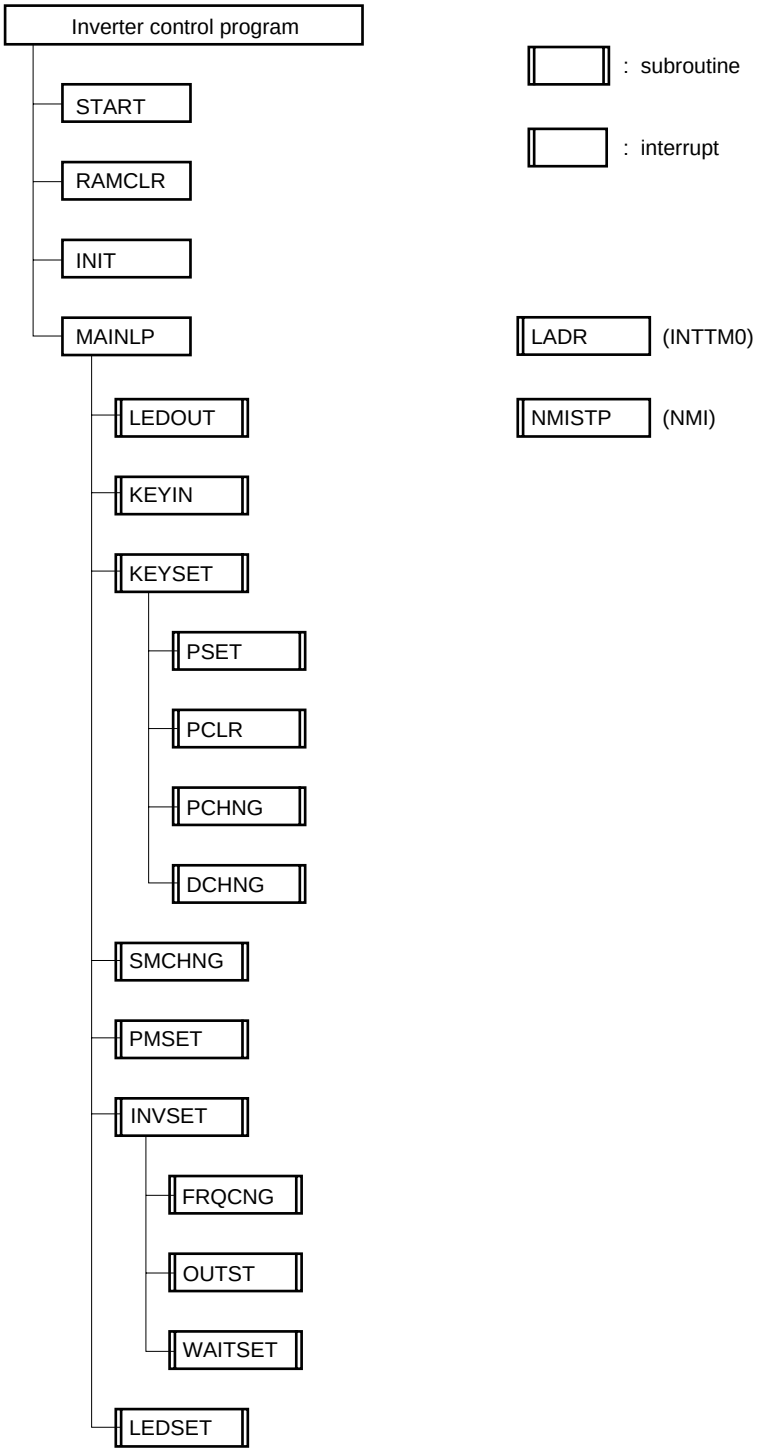
Table 3-2. Subroutines and Interrupt Processing

Symbol	Processing
START	Setting of control register and port mode
RAMCLR	RAM area clear
INIT	Initial setting of variables, selection of synchronous or asynchronous output
MAINLP	Set by key input Setting of inverter output variable Setting of LEDs and test pin output
LEDOUT	Output processing for LEDs and 8-segment LEDs
KEYIN	Key input processing
KEYSET	Key input setting
PSET	Determination of set value according to [ON/OFF] key input
PCLR	Clearing of set value according to [changeover] key input
PCHNG	Change of set value according to [+] or [-] key input
DCHNG	Change of 8-segment LED display according to (changeover) key input
SMCHNG	Setting mode transition processing
PMSET	Main mode transition processing
INVSET	Inverter output setting
FRQCNG	Setting of inverter output variable when changing output frequency
OUTST	Setting of inverter output start
WAITSET	Setting of wait when changing output frequency
LEDSET	Setting of LED and 8-segment LED indications
LADR	Timing set interrupt (context switching)
NMISTP	Safety stop set interrupt (vectored interrupt)

Figure 3-1 illustrates the program composition.

As shown in the figure, processing begins from START. MAINLP processing is performed after the completion of START and INIT processing.

Figure 3-1. Program Composition



3.3 RAM AND FLAGS

Tables 3-3 to 3-6 list the variables and flags used by the sample application.

Depending on the linker, variables and flags are allocated such that they can be relocated. To allocate 2-byte variables to an even-numbered address, however, it is necessary to specify the relocatable attribute.

Table 3-3. Variables Used for Inverter Control (1/2)

Symbol	Bytes	Use, setting, comparison	Set value
PMODE	1	PWM output mode Set by mode transition	Stop mode: 0 Fixed output mode: 1 Output change mode: 2
NFOUT	1	Output frequency Set by inverter output setting	During output: (Target frequency) **Example** 10 Hz: 0AH (10) While stopped: 0FFH
RFOUT	1	Target frequency Set by key setting Perform reference based on inverter output setting.	Output setting: (Target frequency) Stop setting: 0FFH
NCRRY	1	Carrier frequency number Set by key setting Perform reference based on inverter output setting.	Argument at CRRYTBL[] reference 1 - 64H (100)
NDEAD	1	Dead time number Set by key setting Perform reference based on inverter output setting.	Argument at DEADTBL[] reference 5 - 32H (50)
NCHNG	1	Frequency change rate number Set by key setting Perform reference based on inverter output setting.	Argument at CHNGTBL[] reference 0 - 3
NPTRN	1	Change pattern number Set by key setting Perform reference based on inverter output setting.	Argument at PTNTBL[] reference 0 - 9
WAITCNT	2	Frequency change wait counter Set by inverter output setting	After being set, the CHNGTBL[] reference value is decremented by 1 until 0 is reached.
VFP	2	V/f modulation ratio pointer Perform reference and setting based on inverter output setting.	Argument at VFTBL[] reference 0 - 618H (1560)
SADR	2	Value added to sine wave reference phase Perform reference and setting based on INTTM0 processing.	Transfer of BSADR set value
BSADR	2	Transfer buffer used for SADR change Set by inverter output setting	Value added to sine wave reference phase $\frac{\text{(Output frequency)}}{\text{(Carrier frequency)}} \times 4096$
OFFSET	2	Offset revision determined by V/f modulation Perform reference and setting based on INTTM0 processing.	Transfer BOFFSET set value

Table 3-3. Variables Used for Inverter Control (2/2)

Symbol	Bytes	Use, setting, comparison	Set value
BOFFSET	2	Transfer buffer used for OFFSET change Set by inverter output setting	Offset revision determined by V/f modulation $\left\lvert \frac{BVF}{2} - \frac{BCM03}{2} \right\rvert$
VF	2	V/f modulation multiplier Perform reference and setting based on INTTM0 processing.	Transfer BVF set value
BVF	2	Transfer buffer used for VF change Set by inverter output setting	V/f modulation multiplier $\frac{16000000}{2 \times fc} \times \frac{VFTBL[\,]}{1000H}$
BCM03	2	Transfer buffer used for CM03 change Set by inverter output setting	CM03 set value $\frac{16000000}{2 \times fc}$
CRYCNT	2	Carrier wave counter set value Perform reference and setting based on INTTM0 processing.	Transfer BCRYCNT set value
BCRYCNT	2	Transfer buffer used for CRYCNT change Set by inverter output setting Perform reference based on INTTM0 processing.	Carrier wave counter set value $\frac{\text{(Carrier frequency)}}{\text{(Output frequency)}}$
WCRYCNT		Carrier wave counter used for synchronous operation Perform reference, decrement, and setting based on INTTM0 processing.	The CRYCNT set value, after being transferred, is decremented by 1.
PTNP	2	Change pattern pointer Perform reference and setting based on inverter output setting.	Argument at previous PTRNn[] reference (At change pattern output)
BDTIME	2	Transfer buffer used for DTIME change Set by inverter output setting Perform reference based on INTTM0 processing.	(Dead time) x 16 **Example** 5 μs: 3CH (60)
TM0CNT	1	INTTM0 interrupt counter Set by inverter output setting Decrement by INTTM0 processing	Decrement initial value 2 by 1, until 0 is reached.

fo : Output frequency, fc : Carrier frequency

Explanation of major symbols

(1) VFP

The argument at VFTBL[] reference is set. In VFTBL[], to describe the 157 words of the V/f modulation ratio corresponding to 4 to 160 Hz, VFP can be set to a value within the range of 0 to 9DH (157).

(2) SADR, BSADR

The sine wave reference phase increment is set. To equally divide the sine wave table data count (4096 words) by the carrier wave count for one sine wave cycle, calculation is performed as follows:

$\frac{\text{(Output frequency)}}{\text{(Carrier frequency)}}$ x (Sine wave data count)

(3) VF, BVF

Multiplying the V/f modulation multiplier by the SINTBL[] reference value (0 to 0FFFFH) gives a sine wave having an amplitude equal to that of the carrier wave multiplied by the modulation ratio.
The value of VFTBL[] described in the modulation ratio table is equal to (modulation ratio) x 1000H. Therefore, the value set for VF is as follows:

$$\text{(Carrier wave amplitude) x (Modulation ratio)} = \frac{16000000^{\text{Note}}}{2 \times fc} \times \frac{\text{VFTBL[ ]}}{1000H}$$

Note The carrier wave amplitude is obtained by dividing the carrier wave half-cycle (1/(2 x fc)) by the timer count (1/16000000), as follows:

$$\frac{1/(2 \times fc)}{1/16000000} = \frac{16000000}{2 \times fc}$$

(4) OFFSET, BOFFSET

Value set for offset revision determined by V/f modulation.
Within the V/f modulated sine wave data, because the CM03/2 data exists together with much other data, it is necessary to perform offset revision determined by V/f modulation.

(a) When the V/f modulation ratio is greater than or equal to 1, the offset value is decremented.
(b) When the V/f modulation ratio is less than 1, the offset value is incremented.

The value set for the offset determined by V/f modulation is calculated as follows:

$$\left| \frac{VF}{2} - \frac{CM03}{2} \right|$$

(5) BCRYCNT, WCRYCNT, CRYCNT

The carrier wave count for one sine wave cycle is set.
Using synchronous output, decrement by 1 is repeated until 0 is reached. Whether a complete sine wave cycle has been output is determined, and the reference phase in the sine wave table is returned to 0.

BCRYCNT: Transfer buffer used for setting in main processing
WCRYCNT: Decrement counter used for interrupt processing. In the event of an underflow, the value of CRYCNT is re-set.
CRYCNT: Transfers the value of BCRYCNT in interrupt processing.

$$\text{CRYCNT} = \frac{1/(\text{Output frequency})}{1/(\text{Carrier frequency})} = \frac{(\text{Carrier frequency})}{(\text{Output frequency})}$$

Table 3-4. Flags Used for Inverter Control

Symbol	Use, setting	Set value
_CHNGST	Interrupt variable transfer request Set by inverter output setting Reset by INTTM0 processing	Reset: No transfer request Set: Transfer request
_MINIT	Selection of mode initialization processing Set/reset by mode transition processing	Reset: Mode initialization processing unnecessary Set: Mode initialization processing necessary
_PCHNG	Determination of output setting change Set by key setting Reset by inverter output setting	Reset: No setting change Set: Setting changed
_PTNOUT	Change pattern output Used by means of inverter output setting	Reset: Other than during change pattern output Set: During change pattern output
_SYNC	Selection of synchronous/asynchronous operation Set by initialize processing	Reset: Asynchronous output Set: Synchronous output
_BSVF	Transfer flag for _SVF change Set by inverter output setting	Reset: V/f modulation ratio < 1 Set: V/f modulation ratio ≥ 1
_SVF	Indicates V/f modulation ratio. Perform reference and setting based on INTTM0 processing.	Transfer _BSVF set value

Table 3-5. Variables Used for Other Than Inverter Control (1/2)

Symbol	Bytes	Use, setting, comparison	Set value	
NSET	1	Value set by key input Perform reference and setting by means of key setting.	DMODE	Meaning of set value
			10H	Target frequency
			11H	Carrier frequency number
			12H	Dead time number
			03H	Number of frequency change rate
			04H	Number of change pattern
NSETMN	1	Minimum NSET value Perform reference and setting by means of key setting.	DMODE	Meaning of minimum value
			10H	Target frequency
			11H	Carrier frequency number
			12H	Dead time number
			03H	Number of frequency change rate
			04H	Number of change pattern
NSETMX	1	Minimum NSET value Perform reference and setting by means of key setting.	DMODE	Meaning of maximum value
			10H	Target frequency
			11H	Carrier frequency number
			12H	Dead time number
			03H	Number of frequency change rate
			04H	Number of change pattern

Table 3-5. Variables Used for Other Than Inverter Control (2/2)

Symbol	Bytes	Use, setting, comparison	Set value
SFOUT	1	Buffer used for setting target frequency Set by means of key setting Perform reference by means of inverter output setting.	Target frequency set by key setting **Example** 10 Hz: 0AH (10)
KIN	1	Key input Perform reference and setting by means of key setting.	Value input to port (P5)
SMODE	1	Key setting mode Set by setting mode transition processing Perform reference by means of key setting.	00H: PWM output setting 01H: Setting OFF 02H: Change pattern setting
DMODE	1	8-segment LED display mode Perform reference and setting by means of key setting.	10H: Display of output frequency 11H: Display of carrier frequency 12H: Display of dead time 03H: Display of frequency change rate 04H: Display of change pattern
SEGBUF	3	8-segment LED display buffer Perform reference and setting by means of key setting.	8-segment LED 3-digit display character code
SEGCNT	1	8-segment LED flash counter Perform reference and setting by means of LED display setting.	Decrement initial value 0E4H by 1, until 1CH is reached. SEG LED is lit when highest order bit = 1.
LEDCNT	1	LED flash counter Perform reference and setting by means of LED display setting.	Decrement initial value 0E4H by 1, until 1CH is reached. LED is lit when highest order bit = 1.
KSMPCNT	1	Key input sampling counter Perform reference and setting by means of key input.	Decrement initial value 2 by 1, until 0 is reached.
KONCNT	1	Hold-down counter Perform reference and setting by means of key input.	Decrement initial value 13H by 1, until 0 is reached.
KCODE1	1	Key code buffer 1 Perform reference and setting by means of key input. (Key codes are listed in **Table 3-19**.)	Previously input key code 0: NULL 1: [Changeover] 4: [ON/OFF] 2: [-] 3: [+]
KCODE2	1	Key code buffer 2 Perform reference and setting by means of key input.	Input key code As above

Table 3-6. Flags Used for Other Than Inverter Control

Symbol	Use, setting	Set value
_LEDOUT	LED output setting Set/reset by means of LED display setting	Reset: LED not lit Set: LED lit

3.4 TABLES

Table 3-7 lists the data tables used by the sample application.

Table 3-7. Data Tables

Symbol	Bytes	Described value	Argument	Compare processing
SIN[]	4096 x 2	Sine wave data (1 cycle) ···sin θ x 7FFFH + 8000H	rp6 of RB6 and RB7	INTCM03 interrupt processing INTTM0 interrupt processing
VFTBL1[]	157 x 2	V/f modulation ratio (1) ···(modulation ratio) x 800H (4096)	VFP	Inverter output setting
FRQTBL[]	157 x 2	Target frequency **Example** 10 Hz: 0AH (10)	NFOUT	Key setting
CRRYTBL[]	10 x 2	(Carrier frequency) **Example** 1530 Hz: 5FAH (1530)	NCRRY	Inverter output setting
DEADTBL[]	11 x 2	(Dead time) x 16 **Example** 5 μs: 50H (80)	NDEAD	Inverter output setting
FMXTBL[]	10 x 2	(Maximum output frequency value) x 10 **Example** 100 Hz: 3E8H (1000)	NCRRY	Key setting
DMXTBL[]	10	Argument at DEADTBL[] reference	NCRRY	Key setting
CHDSPTBL[]	4 x 2	Rate of frequency change Data for 8-segment LED display	NCHNG	LED display setting
CHNGTBL[]	4 x 2	Rate of frequency change For WAITCNT setting	NCHNG	Inverter output setting
PTNBL[]	10 x 2	Change pattern start address	NPTRN	Inverter output setting
PTRNn[] n: 1 to 10	40 total	Change pattern (Refer to **(4) in Explanation of major symbols**)		Initialization processing Inverter output setting
LEDTBL[]	26	8-segment LED display pattern	Character code	LED display setting

Explanation of major symbols

(1) Sine wave table SIN[]

0 to 2π is divided by 4096 to give the sine wave data for each phase.

Because the sine is a decimal value within the range of the minimum value - 1 to the maximum value + 1, to enable setting as 16-bit integer data, the sine is multiplied by the value shown below.

$$\frac{0FFFEH}{(+1) - (-1)} = 7FFFH$$

Also, to enable reference by means of a compare instruction, -1 is made to correspond to 0, while +1 is made to correspond to 0FFFEH. Therefore, the value described in the sine wave table is equal to 7FFFH + 7FFFH x sin θ.

Example sin (π/6): 7FFFH + 0.5 x 7FFFH = 0BFFFH

(2) V/f modulation ratio table VFTBL[ ]

The V/f modulation ratio is defined for all output frequencies (1561 types, from 4.0 to 160.0 Hz).
The modulation ratio is a decimal number within the range of 0 to 1.6. To enable setting of the modulation ratio as 16-bit integer data, however, the values which appear in the table are obtained by multiplying the modulation ratio by 4096.

Example Modulation ratio 0.8: 1000H x 0.8 = 0CCDH

(3) Dead time table DEADTBL[]

The dead time can be set in units of 1/16 [μs].
Therefore, the values described in the dead time table are equal to sixteen times the actual dead time.
The value set in the dead time setting register DTIME is equal to the DEADTBL[] reference value - 1.

Example Dead time 10 μs: 10 x 16 = 160

(4) Change Pattern PTRNn[ ]

There are ten types of table, from PTRN1[] to PTRN10[].
The values described in the change pattern table are listed in Table 3-8.

Table 3-8. Change Pattern Table

	Described data	Compare processing
Byte 1	Describes the lower limit for the target frequency range, set by key input. **Example** 10 Hz: 0AH (10)	Referenced in change pattern determined for initialization.
Byte 2	Describes initially set value for set carrier frequency number. **Example** 1000 Hz: 5 ··· CRYTBL[5] = 1000	
Byte 3	Describes initially set value for rate of frequency change number. 0.5 Hz/s: 0, 1.0 Hz/s: 1 1.5 Hz/s: 2, 2.0 Hz/s: 3	
Byte 1 + 3n (n ≥ 1)	Describes the output frequency used to change the carrier frequency. **Example** 10 Hz: 0AH (10)	Referenced in output frequency setting made for inverter output setting.
Byte 2 + 3n (n ≥ 1)	Describes the carrier frequency number for the above output frequencies. Change pattern output is terminated by setting 0FFH. **Example** 1000 Hz: 5 ··· CRYTBL[5] = 1000	Referenced from inverter output setting made when byte (1 + 3n) matches the output frequency.
Byte 3 + 3n (n ≥ 1)	Describes the rate of frequency change number for the above output frequencies. **Example** 1.5 Hz/s: 2 (Same as for byte 3)	

In the change pattern table, the number of values described will differ depending on the number of times the carrier frequency and the rate of frequency change are changed. In Table 3-8, when n is an integer equal to or greater than 1, the output frequency, carrier frequency number, and rate of frequency change, after being changed n times, appear as table data.

For the fourth and subsequent bytes reference is made, using the PTNP variable as the argument, by means of inverter output setting.

The PTNP variable is initially set to 4.

After the start of PWM output when inverter output setting is being used, every time the output frequency is set, the PTNP variable is used as the argument for table reference, and that value and the output frequency are compared.

When reference determines that the values match, PTNP + 1 is used as the argument for table reference. Then, the carrier frequency number is set as the reference value and PTNP + 2 is used as the argument for table reference. Subsequently, the rate of frequency change number is used as the reference value.

When the carrier frequency number and rate of frequency change number are changed, 3 is added to the value of PTNP and, the next time the output frequency is set, the value of the reference pointer is updated.

When the table reference value for the carrier frequency number is 0FFH, change pattern output is terminated, and output continues as set by key input.

3.5 REGISTERS

Table 3-9 lists the register banks used by the sample application, as well as those that are not used.

Table 3-9. Register Banks

Number	Use
0	Main processing
1	Not used
2	Not used
3	Not used
4	Not used
5	NMI safety stop interrupt processing
6	Not used
7	INTTM0 timing set interrupt processing

Also, Table 3-10 lists the uses of the registers used in interrupt processing.

Table 3-10. Registers Used in Interrupt Processing

Register	Bank 5	Bank 7
rp0 (AX)	Not used	Accumulator
rp1 (BC)	Input wait	Not used
rp2 (AX')	Not used	PC stack (context switching)
rp3 (BC')	Not used	PSW stack (context switching)
rp4 (VP)	Not used	
rp5 (UP)	Not used	
rp6 (DE)	Not used	Sine wave table reference argument
rp7 (HL)	Not used	Sine wave reference phase

(1) Sine wave reference phase

Indicates the sine wave phase of the output waveform, with 0 - 0FFFFH corresponding to 0 - 2π.

At the start of interrupt processing, the previous sine wave reference phase is set. Every time interrupt processing is performed, the phase is advanced (by adding SADR) to give the current sine wave reference phase.

At the start of output, 0 is initially set.

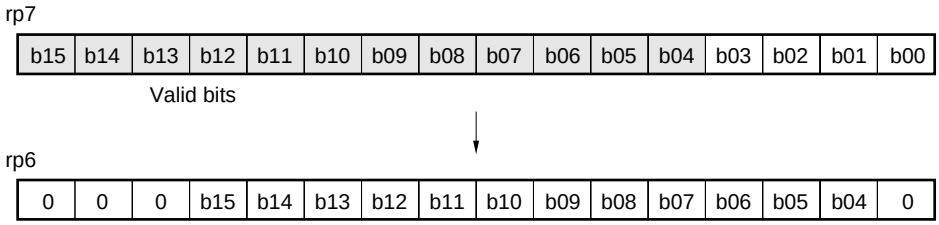
(2) Sine wave table reference argument

This value is used the argument for sine wave table reference.

The phase that is referenced is set in rp7 (HL). However, sine wave data consists of 4096 words, so only the high-order twelve bits are valid.

Four bits in rp6 (DE) are shifted to the right to set a doubled value.

Figure 3-2. rp7, rp6



3.6 PROGRAM DESCRIPTION

3.6.1 Initialization (Symbol name: START, RAMCLR, INIT)

Initialization is performed at a reset start
Initialization is explained below.

- The control register and stack pointer are set (START)
  (as the stack area, twenty bytes of the saddr area, starting from 0FE6CH, are secured)
- Port initialization is performed (START)
- Excluding SFR and register bank 0, all of internal RAM is cleared (RAMCLR)
- Initial setting of interrupts and the real time pulse unit is performed (INIT)
- Synchronous or asynchronous output is selected (INIT)

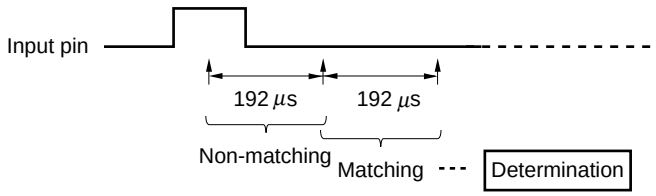
(1) Selection of synchronous/asynchronous output

Synchronous or asynchronous output is selected according to the synchronous/asynchronous input (P90).

To select synchronous output	Set _SYNC
To select asynchronous output	Reset _SYNC

To eliminate the effect of noise, identical input must be read two times consecutively to be effective (**Figure 3-3**).

Figure 3-3. P90 Input Sampling



3.6.2 Main Processing

In the main processing loop, the following processing is performed every 5 ms.

- LED, 8-segment LED output
- Key input
- Key setting
- Setting mode transition
- Main mode transition
- Inverter output setting
- LED, 8-segment LED display setting

(1) LED, 8-segment LED output

LED output is performed according to the LED display setting (_LEDOUT)

_LEDOUT: Set LED lit
_LEDOUT: Reset LED not lit

Also, 8-segment LED digit switching and segment output change are performed.

Figure 3-4. Digit Switching

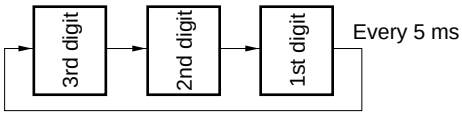


Table 3-11. Segment Display Pattern

Display	a	b	c	d	e	f	g	h
0	1	1	1	1	1	1	0	0
1	0	1	1	0	0	0	0	0
2	1	1	0	1	1	0	1	0
3	1	1	1	1	0	0	1	0
4	0	1	1	0	0	1	1	0
5	1	0	1	1	0	1	1	0
6	1	0	1	1	1	1	1	0
7	1	1	1	0	0	1	0	0
8	1	1	1	1	1	1	1	0
9	1	1	1	1	0	1	1	0
—	0	0	0	0	0	0	1	0
d	0	1	1	1	1	0	1	0
o	0	0	1	1	1	0	1	0
P	1	1	0	0	1	1	1	0
Off	0	0	0	0	0	0	0	0

Figure 3-5. Segment Arrangement

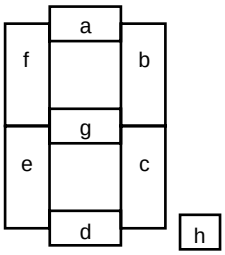
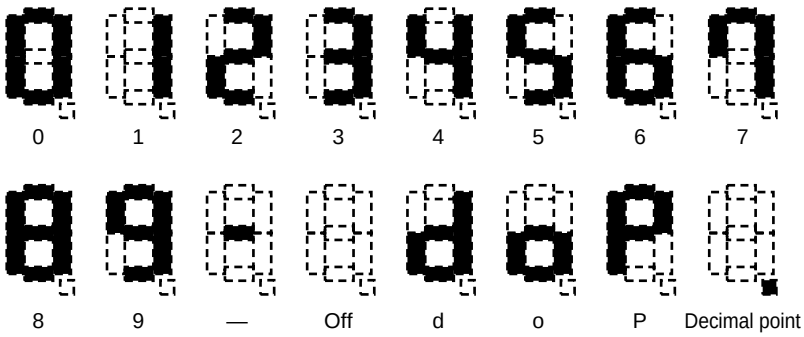


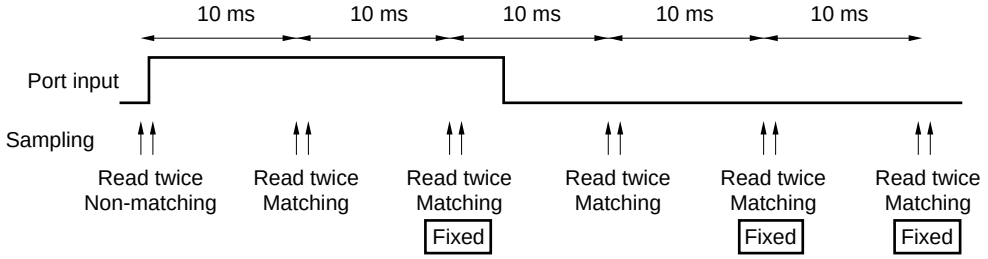
Figure 3-6. 8-Segment LED Display Pattern



(2) Key input

As shown in Figure 3-7, key input port sampling is performed, and fixed code KCODE2 is set.
Also, at the beginning of input processing, to transfer KCODE2 to KCODE1, KCODE1 is set to the key code fixed at the previous sampling.

Figure 3-7. Key Input Port Sampling



If the [ON/OFF], [+], [-], and [changeover] keys are pressed simultaneously, only the key having the highest priority is effective.

Table 3-12. Key Input Priority

Key	Port	Code	Priority
[ON/OFF]	P54	04H	High
[+]	P55	03H	↑
[-]	P56	02H	↓
[Changeover]	P57	01H	Low

(3) Key setting

Processing for the key set by key input (KCODE2) is performed.
When KCODE1 ≠ KCODE2, new input is considered.
The processing performed for each input key is listed in Table 3-13.

Table 3-13. Processing Performed for Input Keys

Input key	Processing performed according to mode		
	Table setting mode	Output setting mode	OFF mode
[ON/OFF]	Change pattern table (NPRTN) fixed	Output setting value NSET fixed Set _PCHNG	Output start (During stop) RFOUT ← SFOUT Output stop (During output) RFOUT ← 0FFH
[+]	Change pattern number increment	NSET increment (+1)	
[-]	Change pattern number decrement	NSET decrement (-1)	
(Changeover)	Invalid	Output set value NSET clear	Display mode DMODE change

(4) Setting mode transition

Key input setting mode transition is performed. Table 3-14 lists the setting mode state transitions for key input. During mode processing for “states” **<1>** to **<3>**, upon the occurrence of the events indicated by "factor," transition to the mode corresponding to the number shown is performed.

A “ — ” in a column indicates that the key is valid and that state transition is not performed.
A “ — ” in a column indicates that the key is invalid.

Table 3-14. Setting Mode State Transition

Mode \ Key		[ON/OFF]	[+]	[–]	[Changeover]
<1>	Table setting	**<3>**	—	—	—
<2>	Output setting	**<3>**	—	—	**<3>**
<3>	OFF	—	**<2>**	**<2>**	—

Remark Upon a reset start, table setting mode **<1>** is assumed.

(5) Main mode transition

As indicated in Table 3-1 “State Transition,” inverter output mode MMODE is changed and _MINIT is set.
_MINIT is the flag used for mode initialize processing, that is set only when the state is changed (upon a reset start, depending on the initialize processing, stop mode is assumed). Table 3-15 lists the values set for MMODE.

Table 3-15. MMODE Set Values

Main mode	MMODE
(Protection) stop mode	0
Fixed output mode	1
Output change mode	2

(6) Inverter output variable setting (subroutine: INVSET)

In output change mode (MMODE = 2), every time the wait counter (decremented by 1 every 5 ms) reaches 0, output frequency NFOUT is incremented or decremented by 1 such that it corresponds as closely as possible to set target frequency RFOUT.
When the output frequency is changed, and when the settings of the carrier frequency, dead time, and rate of frequency change are changed by key input (_PCHNG: set), the value of the transfer buffer for interrupt variable setting is calculated as indicated in Table 3-16 (the method of calculation is given in **Table 3-3**).
To reference the interrupt variable by means of interrupt processing, a value is set in the transfer buffer during main processing, and _CHNGST is set.
During interrupt processing _CHNGST is checked and, if set, the interrupt variable is set to the value in the transfer buffer and _CHNGST is reset (**Figure 3-8**).

Table 3-16. Interrupt Variables and Transfer Buffer

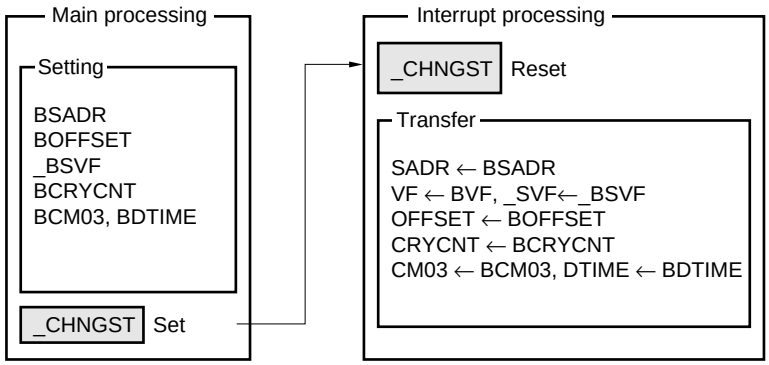
Transfer buffer	Interrupt variable
BSADR	SADR
BOFFSET	OFFSET
BVF	VF
BCRYCNT	CRYCNT
_BSVF	_SVF
BCM03	
BDTIME	

Remark The values of BCM03 and BDTIME are transferred to CM03 and DTIME of sfr.

Table 3-17. Wait Counter Set Values

Rate of frequency change	Wait counter set value	Remarks
0.5 Hz/s	400	Wait time
1.0 Hz/s	200	(Counter value) x 5 [ms]
1.5 Hz/s	133	
2.0 Hz/s	100	

Figure 3-8. Interrupt Variable Setting



Also, while _MINIT is set, mode initialize processing (output start, stop setting) is performed (**Table 3-18**).

Table 3-18. Output Start, Stop Setting

	Output start setting	Output stop setting	Subroutine
RPU output	Enabled	Prohibited	OUTST
Interrupt processing	Enabled	Prohibited	OUTST
Output frequency	Set to 4 Hz	Stop setting	INVSET
Wait	Set	Not set	WAITSET
Interrupt variable	Set	Not set	FRQCNG

(7) LED and 8-segment LED display setting

The current PWM output signal state is set as shown below.

LED At PWM output (MMODE ≠ 0) _LEDOUT is set
At PWM output (MMODE = 0) _LEDOUT is reset

8-segment LED Depending on display mode DMODE, the character code to be displayed is set in 8-segment LED display buffer SEGBUF.

Table 3-19. Character Codes

Character	Code	Character	Code	Character	Code	Character	Code	Character	Code
0	00H	5	05H	d	0AH	0.	10H	5.	15H
1	01H	6	06H	o	0BH	1.	11H	6.	16H
2	02H	7	07H	P	0CH	2.	12H	7.	17H
3	03H	8	08H	" "	0DH	3.	13H	8.	18H
4	04H	9	09H			4.	14H	9.	19H

Remark There are no character codes above 0EH, 0FH and 1AH

Table 3-20. 8-Segment LED Display in Each Mode

	When OFF mode is set		When other than OFF mode is set		Remarks
	LED	8SEG LED	LED	8SEG LED	
Change pattern selection			Not lit	P01	When pattern 1 is set
Signal output stopped					
Target frequency	Not lit	65	Not lit	65	When 65 Hz is set
Carrier frequency	Not lit	10.0	Not lit	10.0	When 10000 Hz is set
Dead time	Not lit	d10	Not lit	d10	When 10 μs is set
Rate of frequency change	Not lit	o2.0	Not lit	o2.0	When 2 Hz/s is set
Output frequency change					
Target/Output frequency	Flashing	65	Flashing	65	When 65 Hz is set
Carrier frequency	Flashing	10.0	Flashing	10.0	When 10000 Hz is set
Dead time	Flashing	d10	Flashing	d10	When 10 μs is set
Rate of frequency change	Flashing	o2.0	Flashing	o2.0	When 2 Hz/s is set
Fixed frequency output					
Target/Output frequency	Flashing	65	Flashing	65	When 65 Hz is set
Carrier frequency	Flashing	10.0	Flashing	10.0	When 10000 Hz is set
Dead time	Flashing	d10	Flashing	d10	When 10 μs is set
Rate of frequency change	Flashing	o2.0	Flashing	o2.0	When 2 Hz/s is set

Remark indicates flashing display (50% duty, 1-s cycle). The flash cycle is reset every time key input is performed.

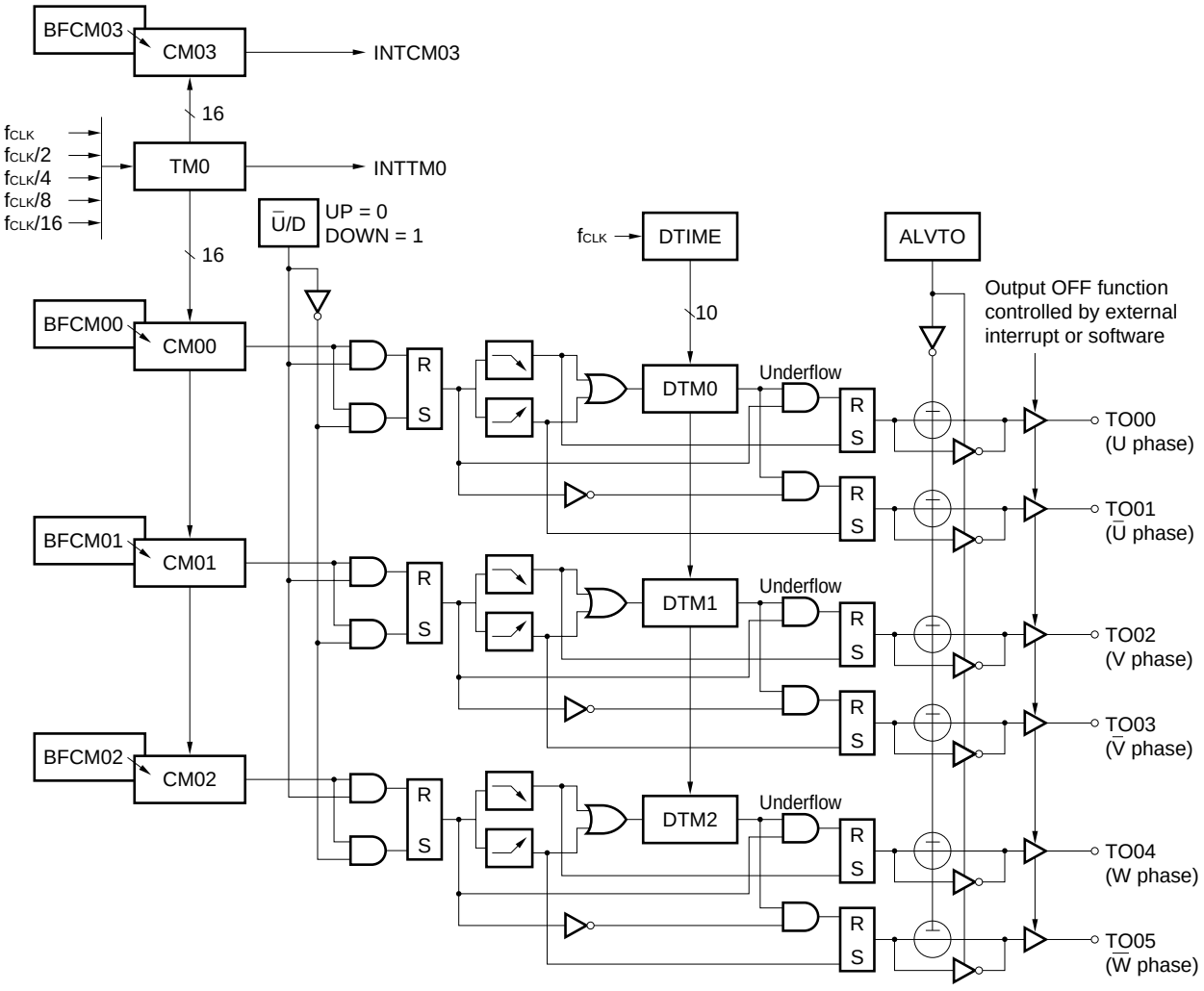
3.6.3 Setting PWM Switching Timing

Figure 3-9 shows the configuration of the μPD78366A real time pulse unit (RPU) while sawtooth wave modulation is being performed.

As shown in Figure 3-9, the carrier frequency is set in compare register CM03 and the dead time is set in dead time setting register DTIME. The timings at which switching is performed are set in transfer buffers BFCM00 - BFCM02.

Upon the occurrence of the INTTM0 interrupt, the values set in BFCM00 - BFCM02 are transferred to compare registers CM00 - CM02 (**Figure 3-10**).

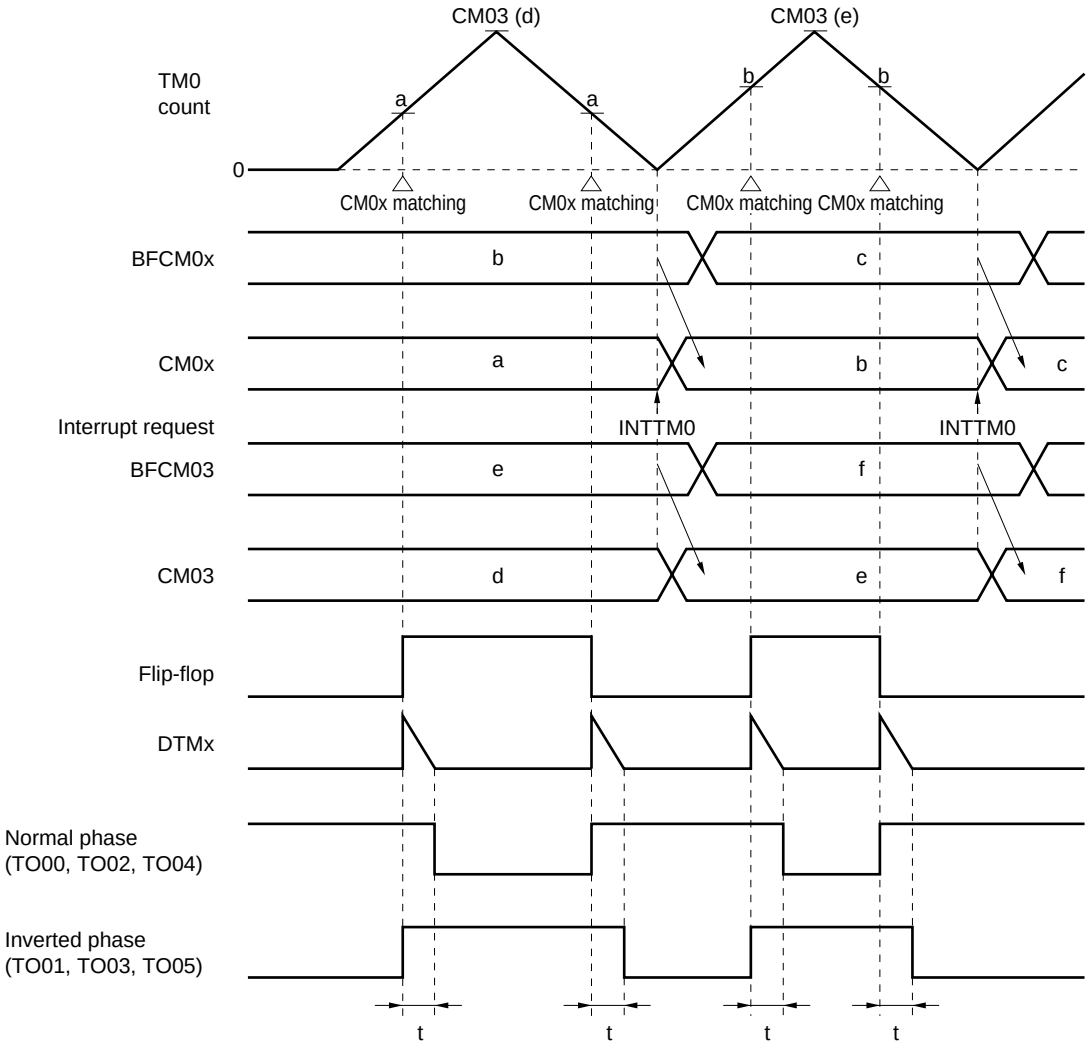
Figure 3-9. RPU Configuration (TM0, Mode 0, Symmetrical Control with Respect to a Vertical Line)



TM0:	Timer register	DTM0 to DTM2:	Dead time timers
CM00 to CM03:	Compare registers	ALVTO:	Bit 2 of the TUM0 register
BFCM00 to BFCM03:	Buffer registers	U/D:	Bit 3 of the TMC0 register
DTIME:	Reload register		

Remark f_{CLK}: Internal system clock

Figure 3-10. RPU Operation Timing (TM0, Mode 0, Symmetrical Control with Respect to a Vertical Line)



Remarks 1. The above timing chart applies when transfer from BFCM03 to CM03 has been enabled by setting the B3TR bit of the TMC0 register to 1. When B3TR is set to 0, TM0 rise and fall cycles are set by directly writing to CM03, without transfer from BFCM03.

2. x = 0 to 2

3. t: dead time = (DTIME + 1) x T_{CLK} (T_{CLK}: system clock rate)

4. To eliminate the dead time, set the CED bit of the TMC1 register to 0.

5. The TO00 to TO05 signals in the above timing chart are active low.

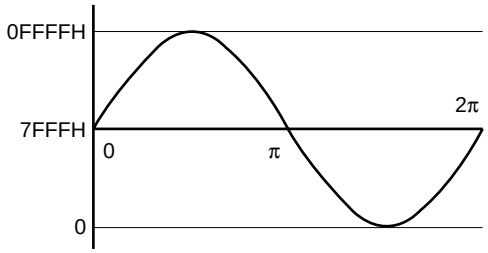
The setting of the timing for BFCM00 - BFCM02 is explained below.

(1) Sine wave data reference

Sine wave table reference is performed according to the output phase.

The range of the reference value is between 0 - 0FFFFH, as shown in Figure 3-11.

Figure 3-11. Sine Wave Table

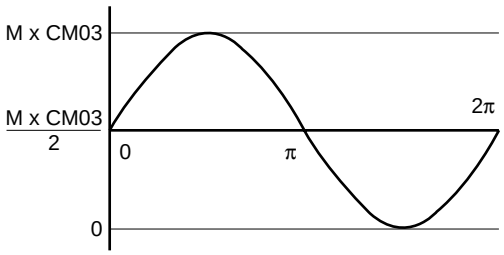


(2) V/f modulation

The sine wave data is multiplied by V/f modulation ratio VF.

The high-order 16 bits correspond to the carrier frequency multiplied by the modulation ratio (**Figure 3-12**).

Figure 3-12. V/f Modulation



(3) Offset revision according to V/f modulation

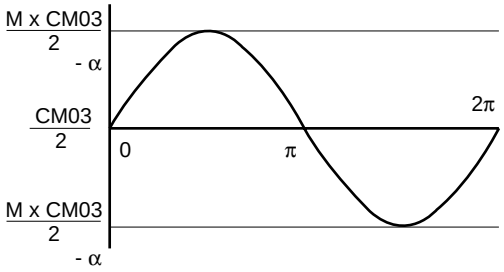
Within the V/f modulated sine wave data, because the CM03/2 data exists together with much other data, offset revision according to the V/f modulation is performed.

When the V/f modulation ratio is greater than or equal to 1, the offset value is decremented. When the V/f modulation ratio is less than 1, the offset value is incremented.

The value set for the offset determined by V/f modulation is calculated as follows:

$$\left| \frac{VF}{2} - \frac{CM03}{2} \right|$$

Figure 3-13. Offset Revision According to V/f Modulation



(4) Timing setting

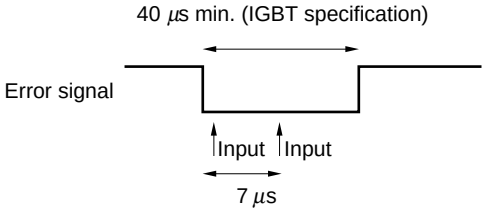
The value obtained by performing steps (1) to (3), above, is set in BFCM0X.

3.6.4 NMI Safety Stop Processing

Processing starts at the falling edge of the external interrupt input to the NMI input pin.

To prevent the occurrence of a safety stop that is caused by noise, NMI pin sampling is repeated during interrupt processing. Stop setting is performed only when two consecutive reads of the active (low) level give the same value.

Figure 3-14. Safety Stop Conditions



During stop setting, RPU output is prohibited and target frequency RFOUT is set to the stop setting (0FFH).

During main processing, when the target frequency is set to the stop setting, the main mode is also set to the stop setting. Also, timing set interrupt is prohibited.

3.6.5 Dead Time Input

During other than PWM output processing, to measure the dead time of the CPU, test pin (P07) output is performed.

Test pin output consists of the processing shown below.

(1) Inverter output setting (subroutine: INVSET)

P07 is set immediately before the subroutine call of the main loop.

P07 is reset immediately after the subroutine call of the main loop.

(2) INTTM0 interrupt processing

At the beginning of interrupt processing, the P07 output value is saved, and P07 is set.

After the completion of interrupt processing, the saved value is restored.

[MEMO]

CHAPTER 4 CAUTIONS

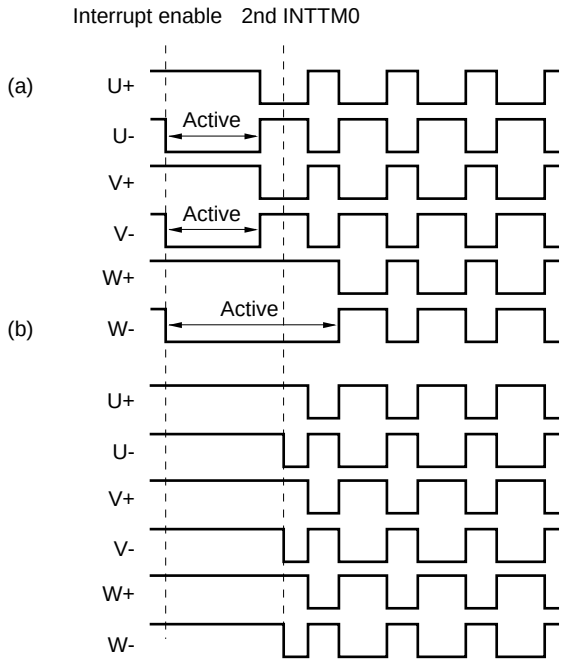
4.1 PWM OUTPUT START TIMING

At the start of timing set interrupt (INTCM03 and INTTM0), PWM output enable setting is performed, and the U-phase and V- phase are set to active output for a period equal to (1.5 x carrier cycle).

Also, the W- phase is set to active output for a period equal to (2.5 x carrier cycle) (**Figure 4-1(a)**).

While the motor is stopped, active output is performed as described above, such that there is the possibility of an overcurrent flowing. Therefore, PWM output enable setting is performed at the second INTTM0 interrupt (**Figure 4-1(b)**).

Figure 4-1. PWM Waveform at Output Start

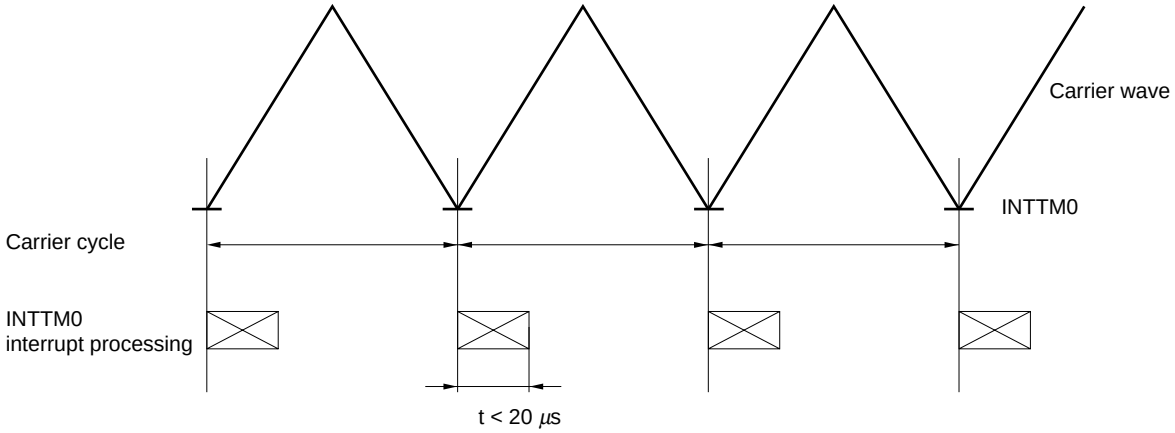


4.2 TIME REQUIRED FOR TIMING SET INTERRUPT PROCESSING

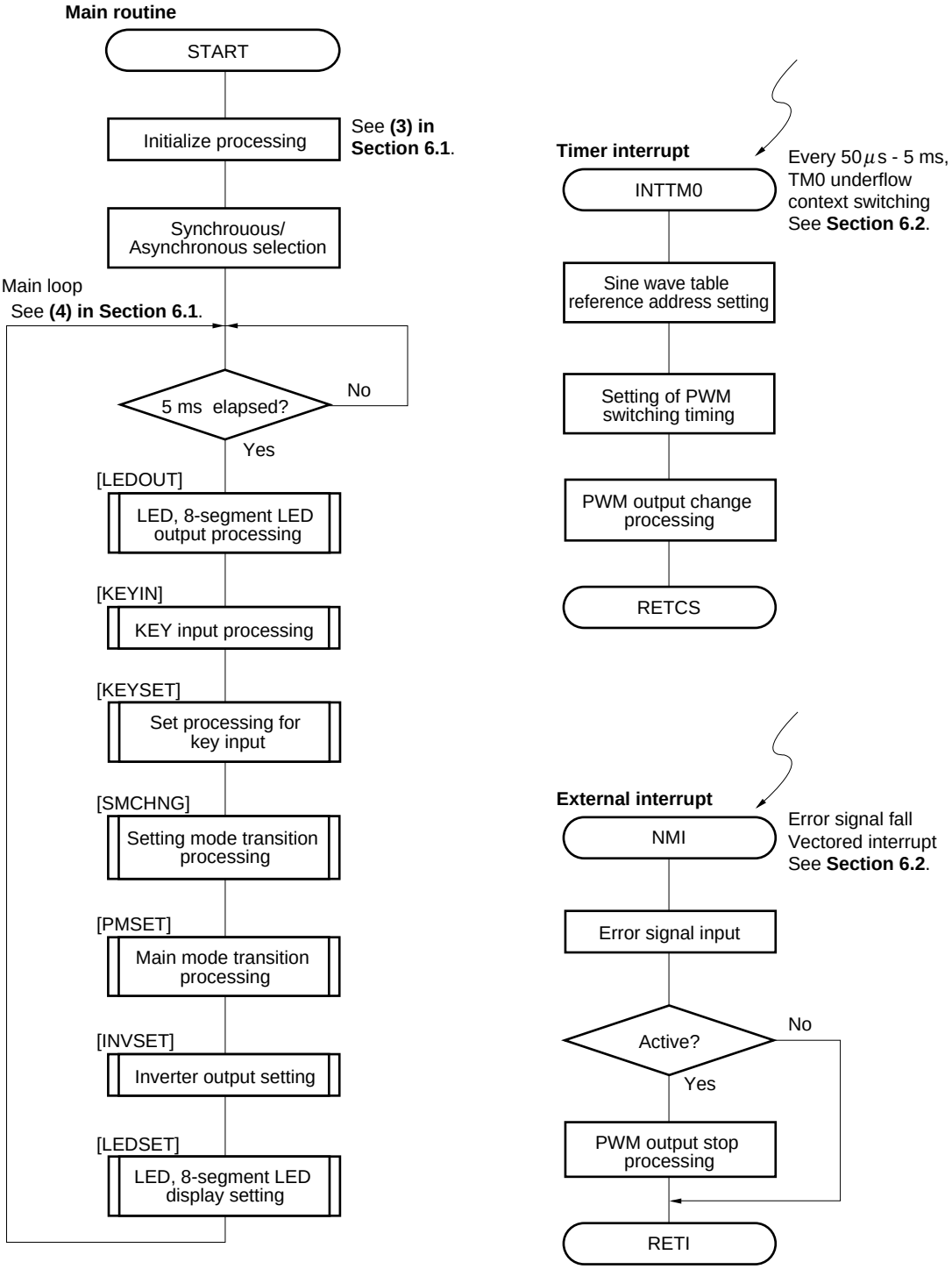
In the sample application, the switching timing for PWM output is calculated based on the interrupt processing for each carrier cycle.

Therefore, within one carrier cycle, it is necessary to secure the time required to perform interrupt processing (20 μs).

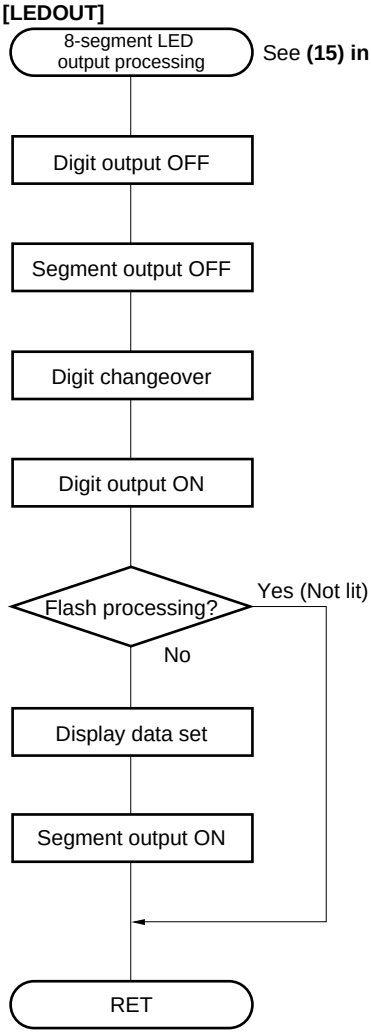
Figure 4-2. Time Required for Timing Set Interrupt Processing



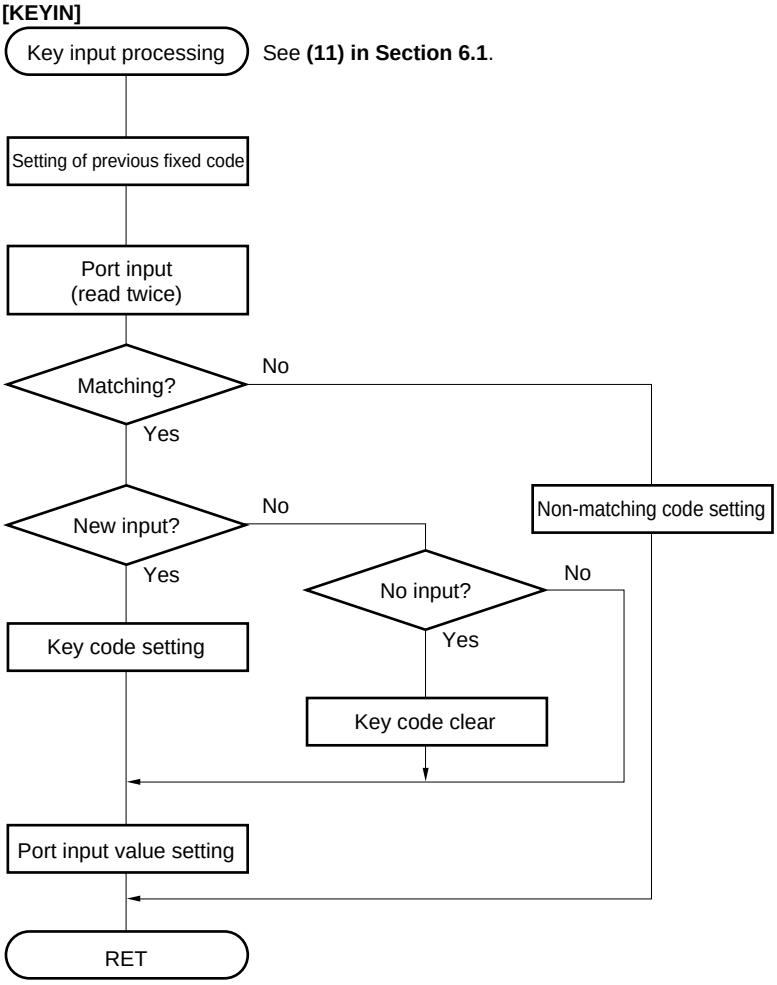
CHAPTER 5 FLOWCHARTS



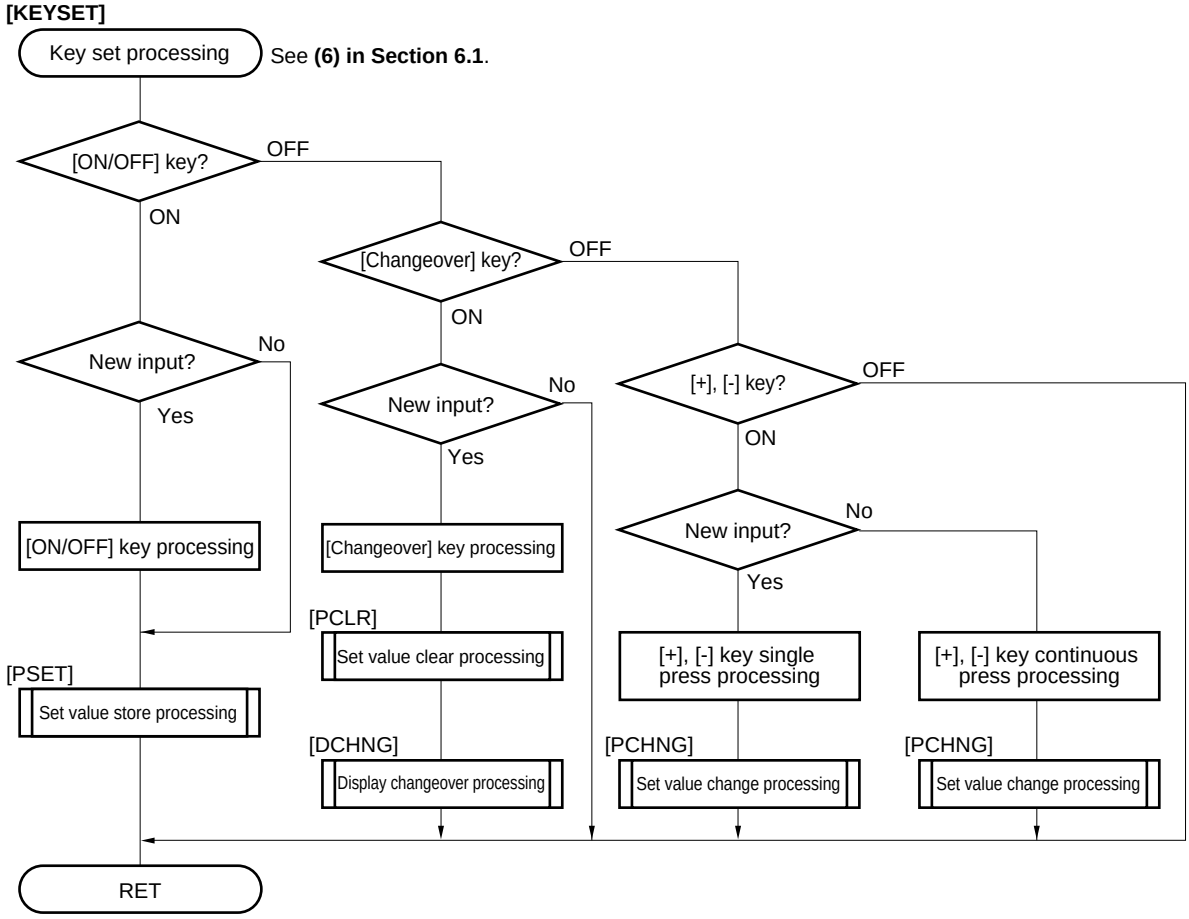
[LEDOUT]



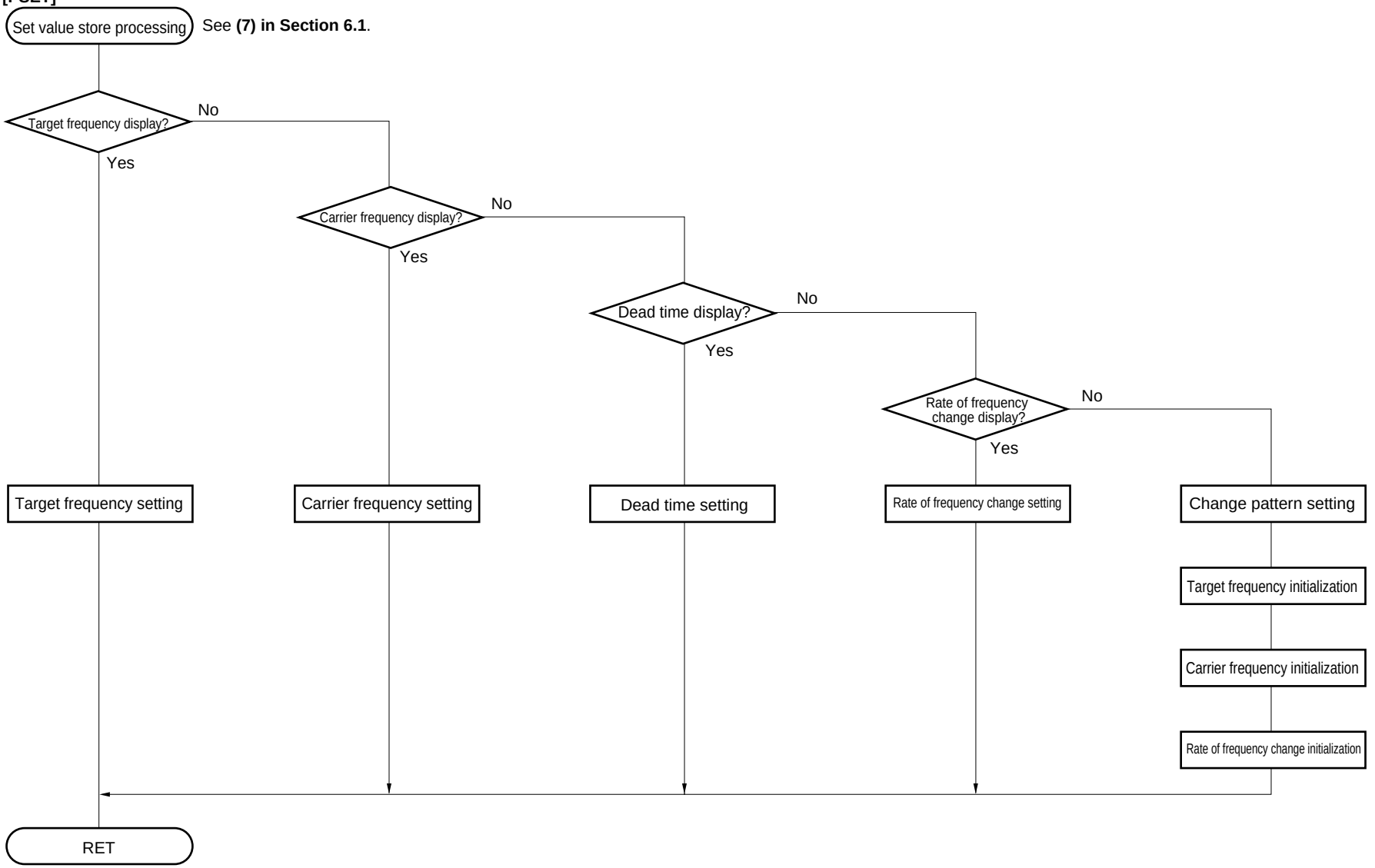
[KEYIN]



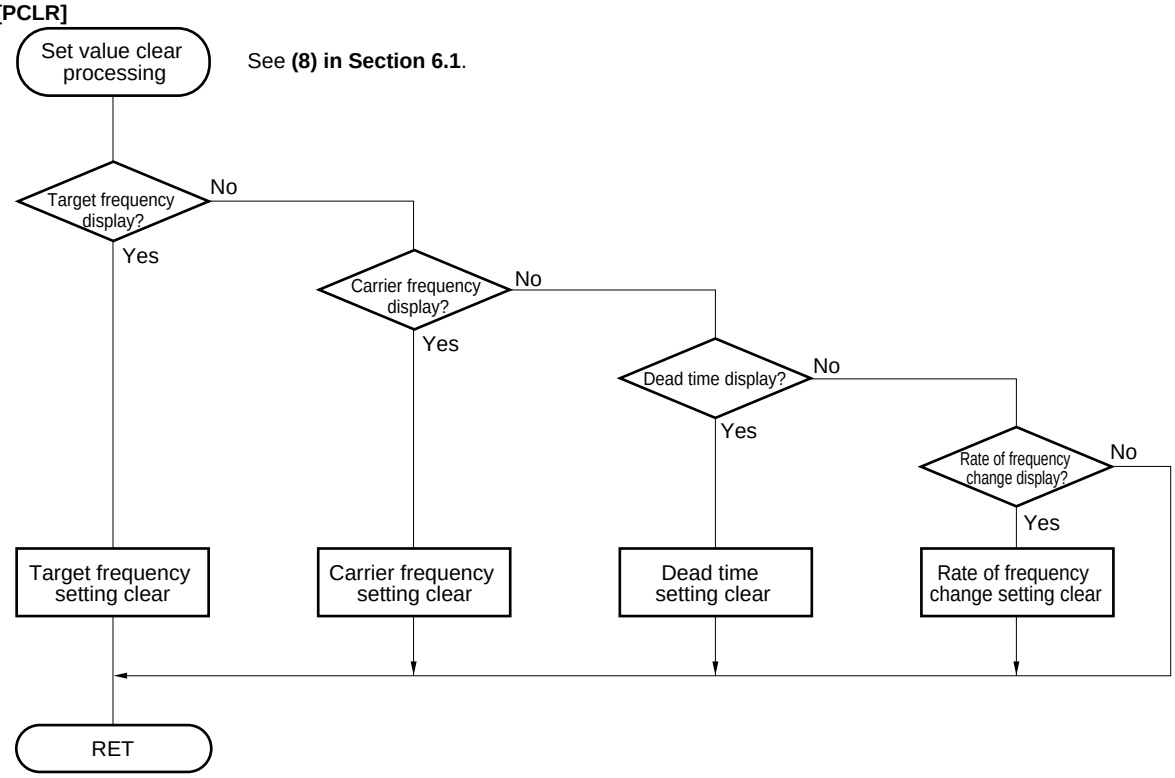
[KEYSET]



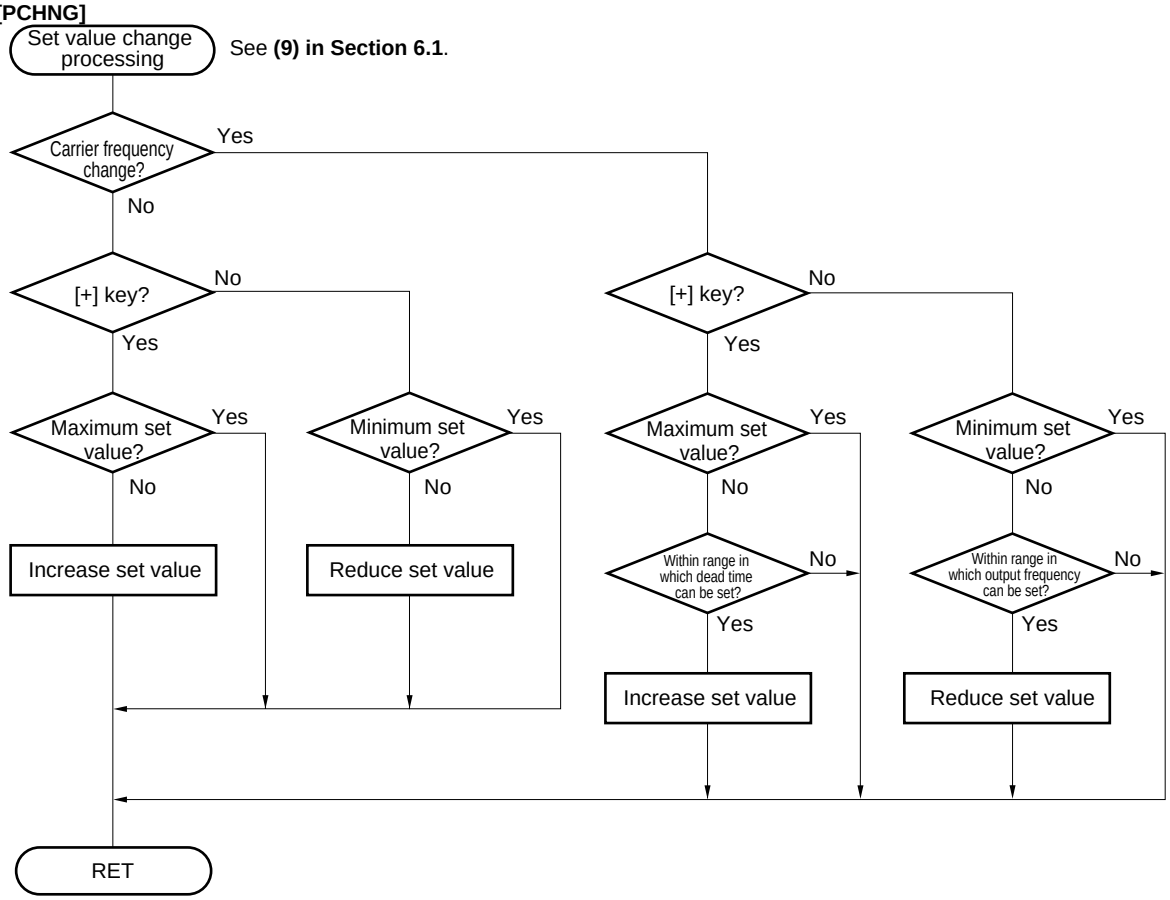
[PSET]



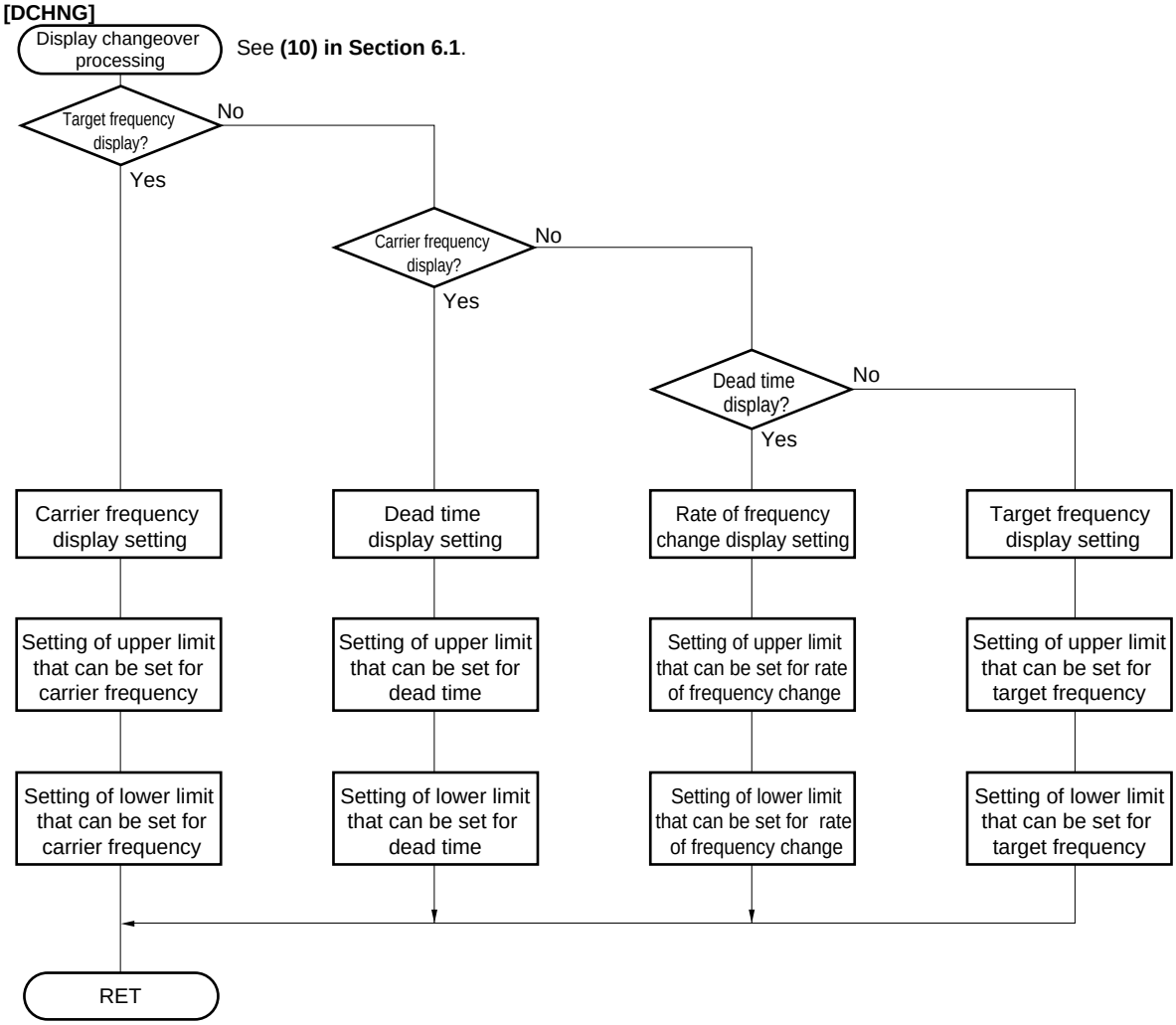
[PCLR]



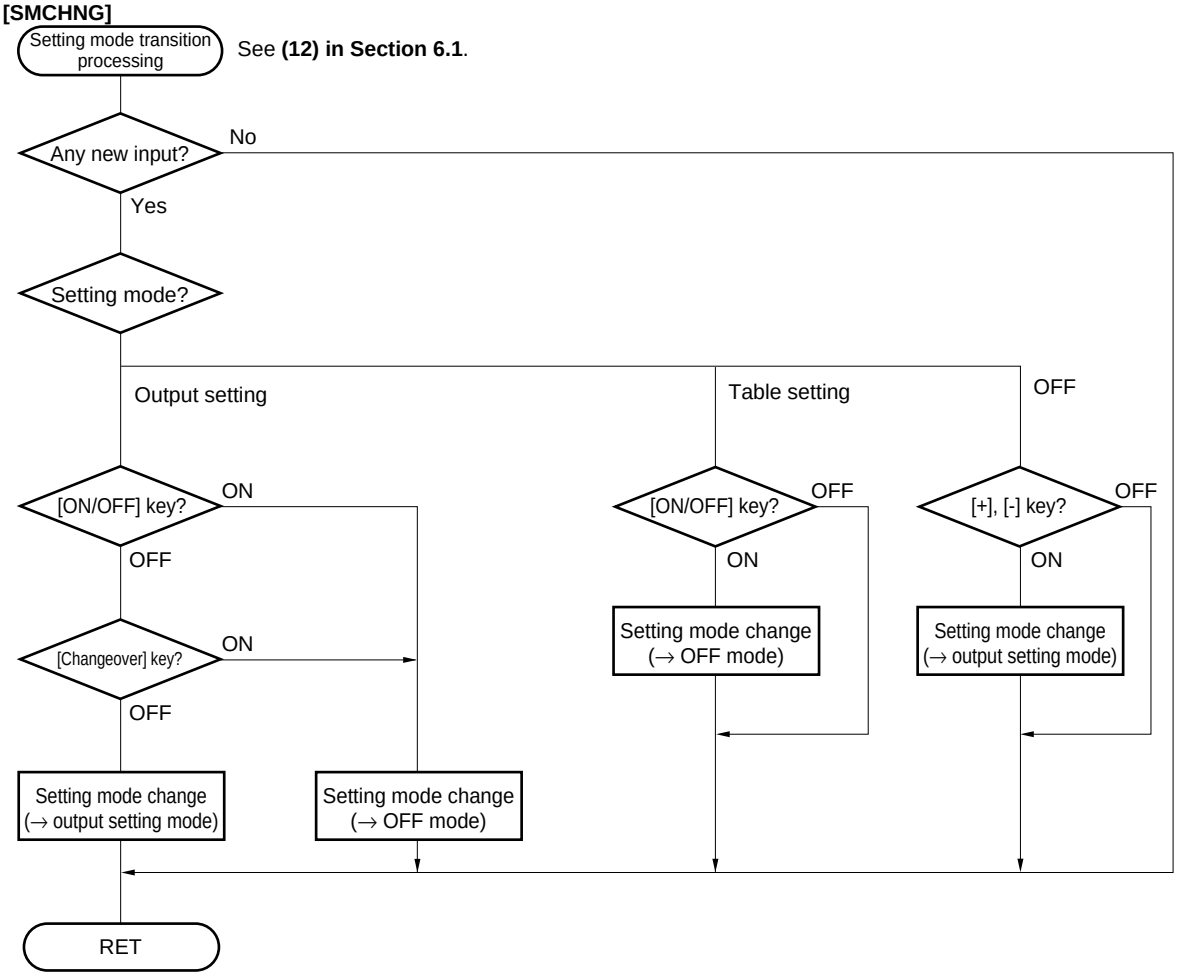
[PCHNG]



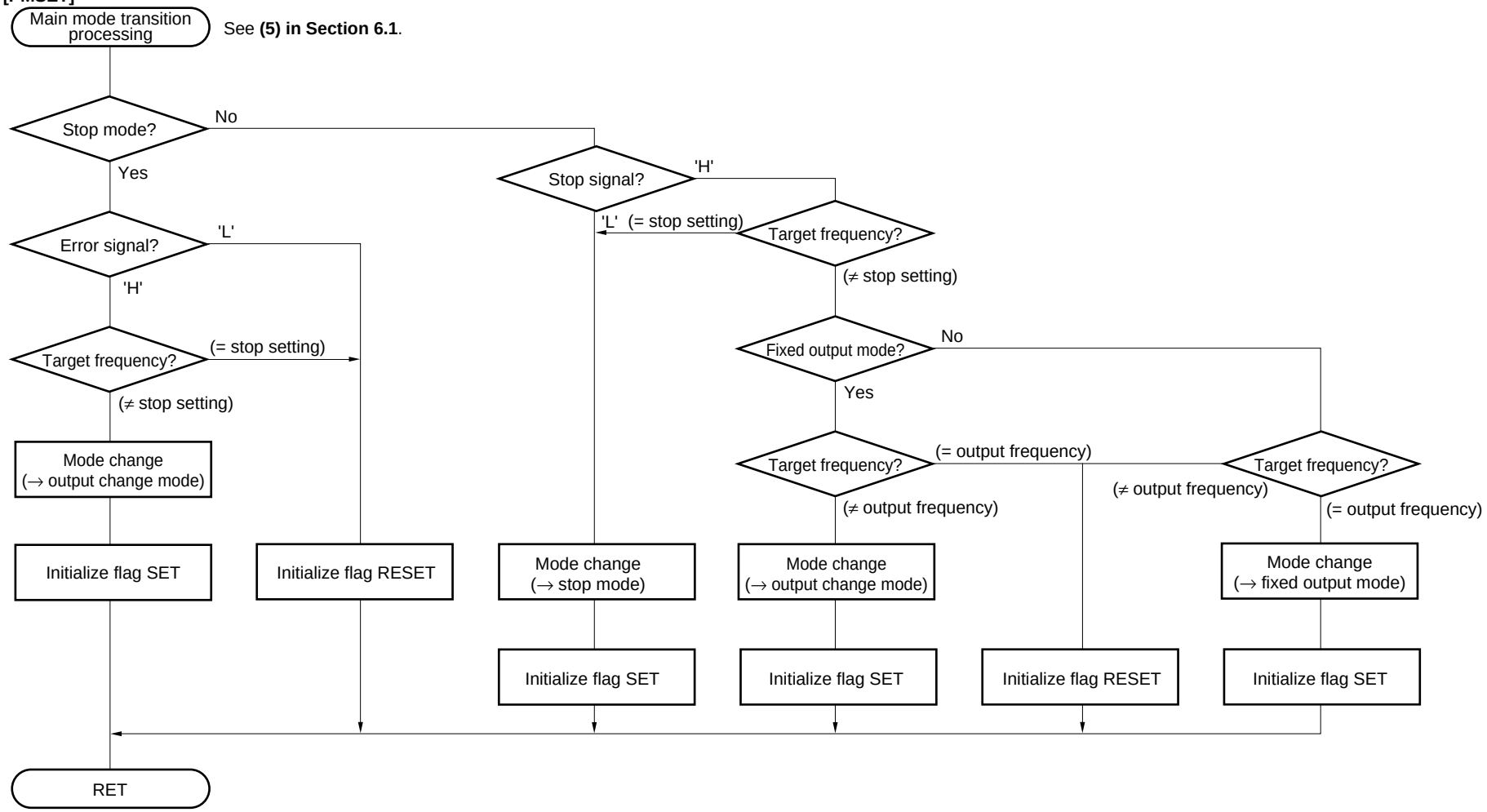
[DCHNG]



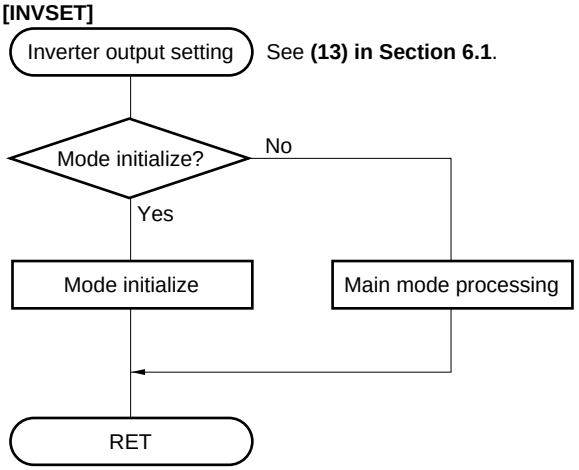
[SMCHNG]

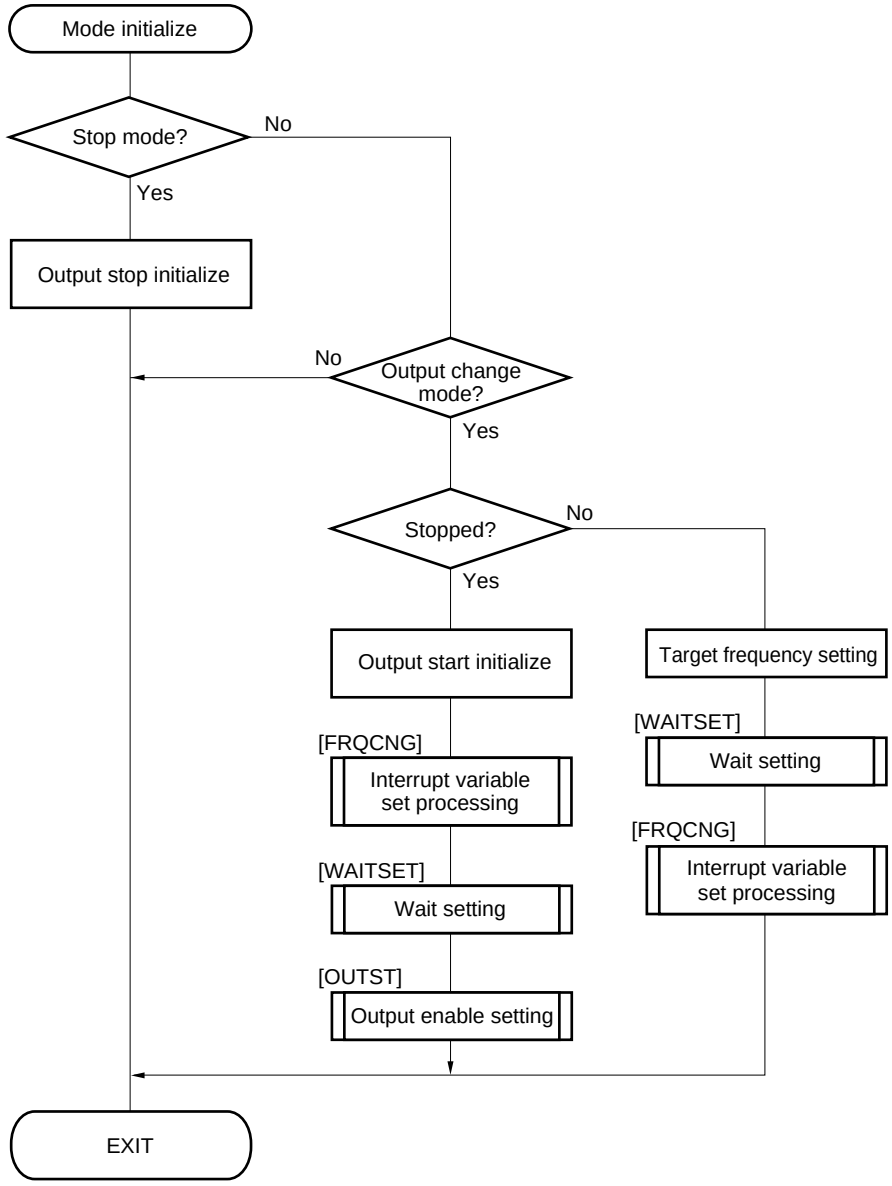


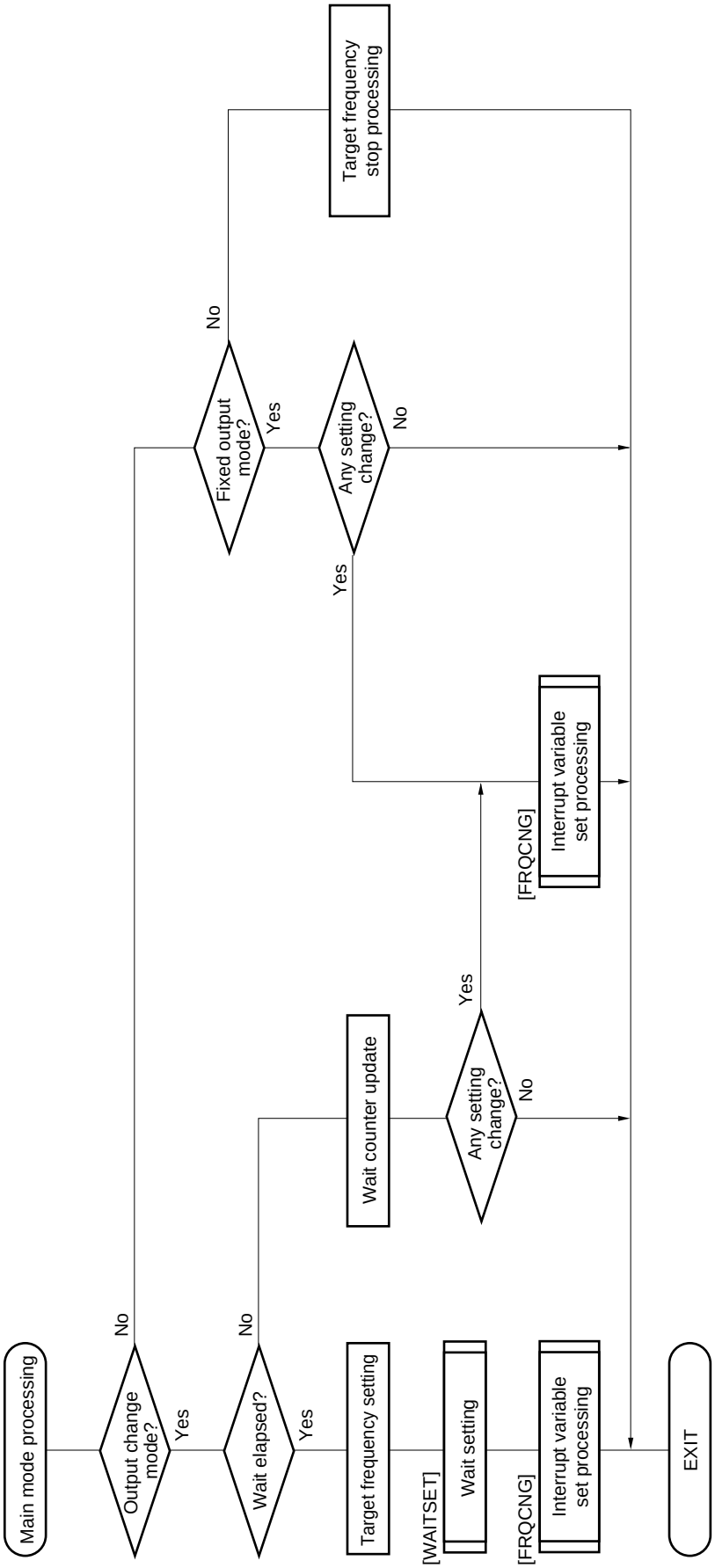
[PMSET]



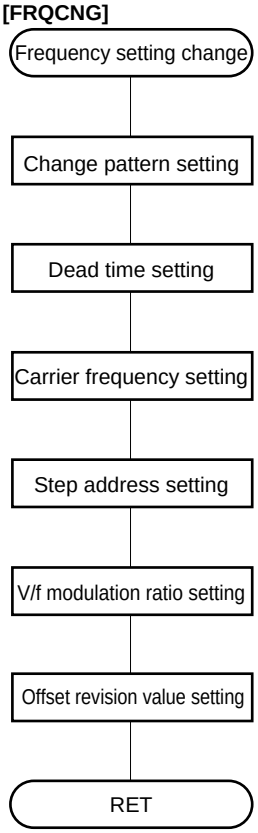
[INVSET]



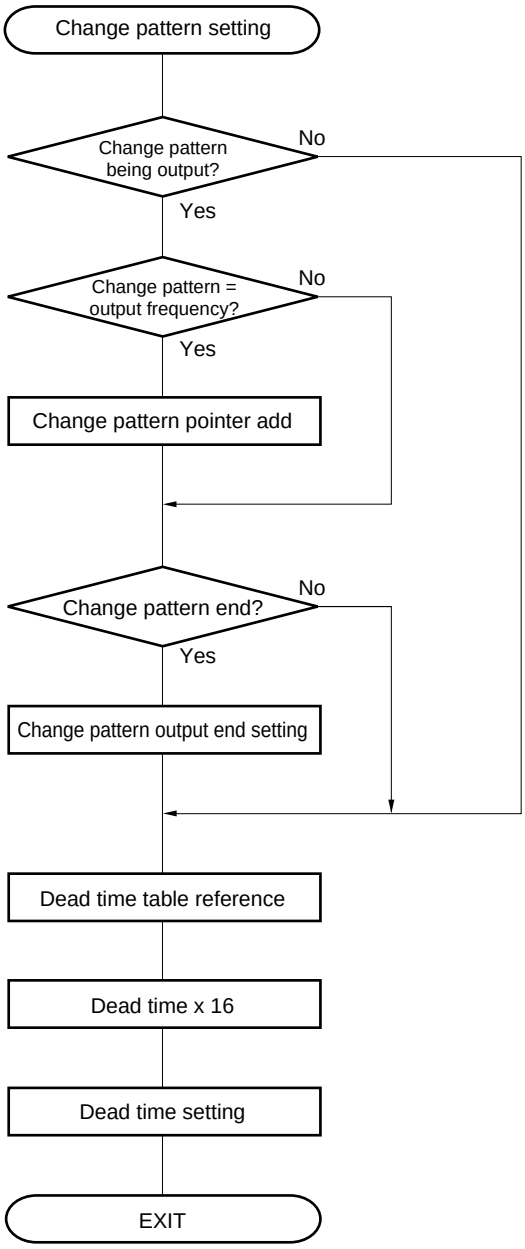


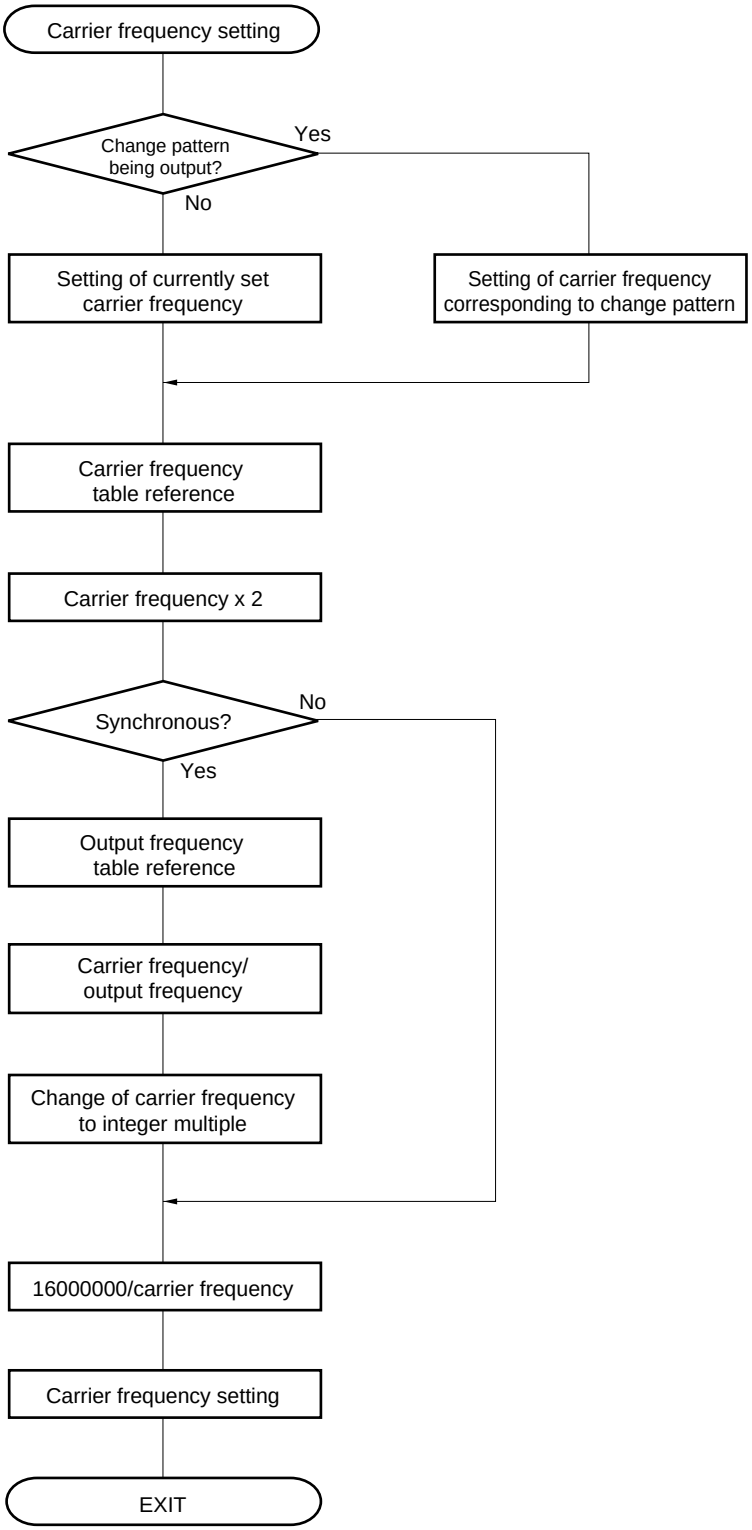


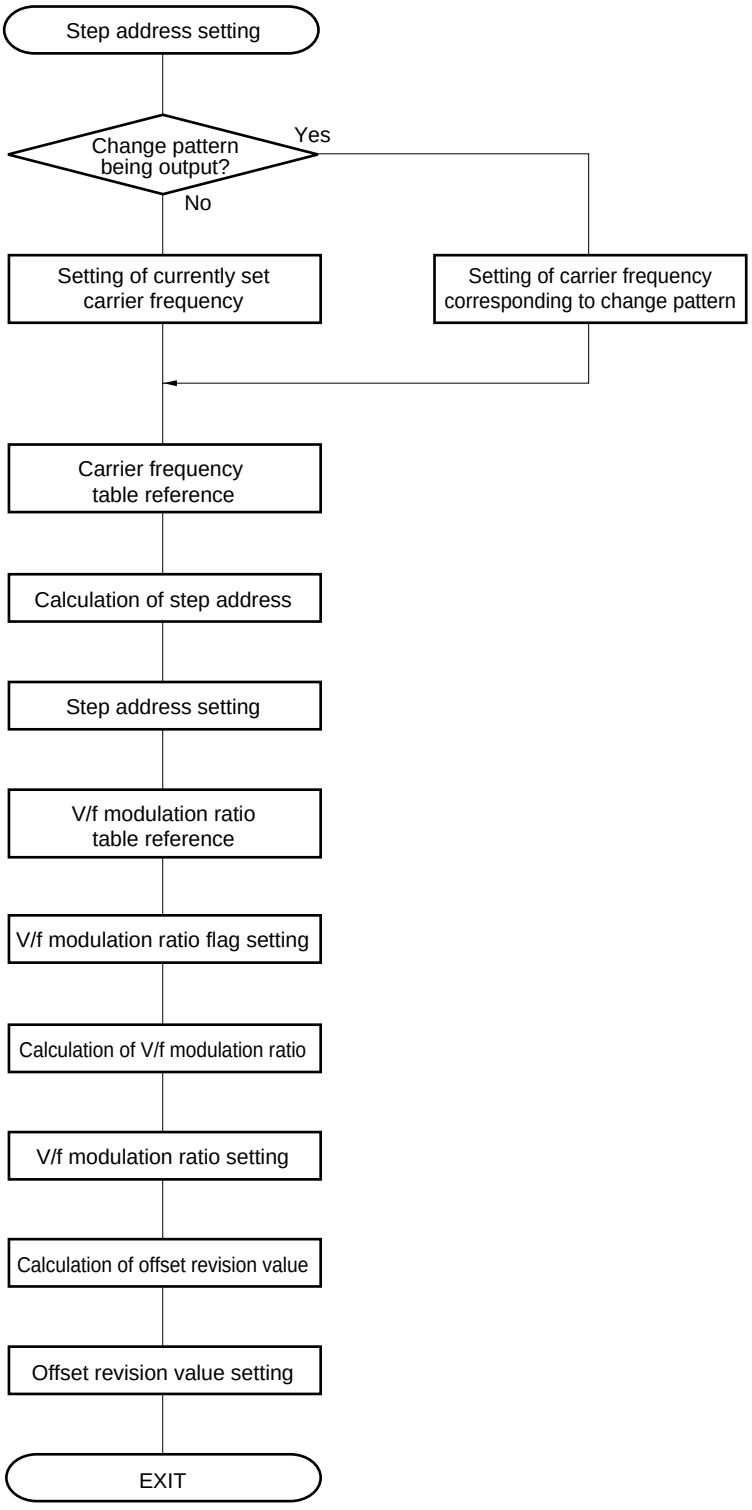
[FRQCNG]



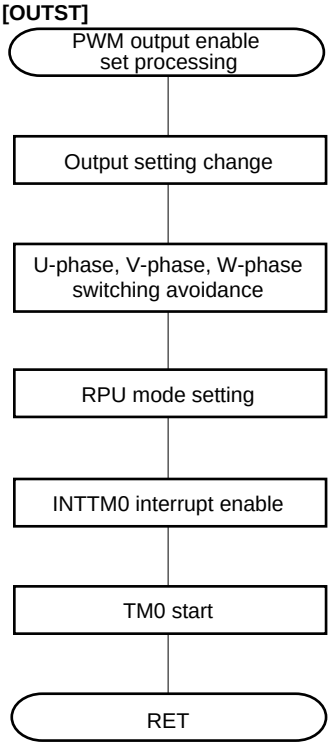
See **(18) in Section 6.1**.



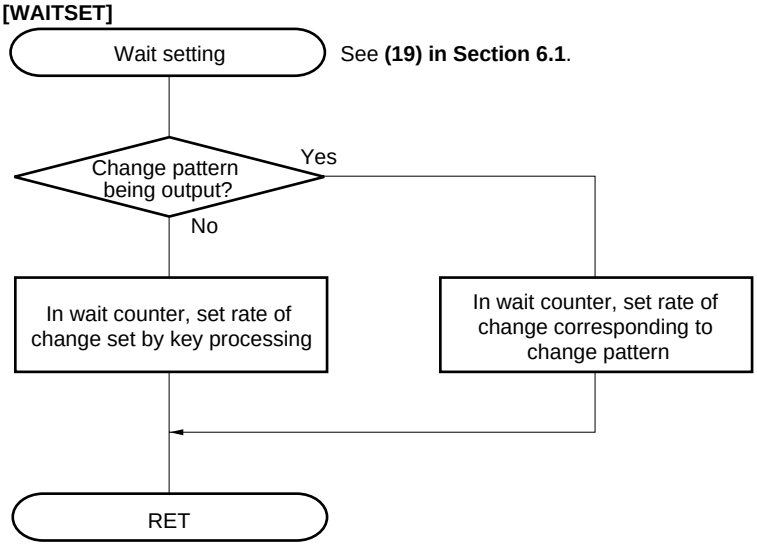




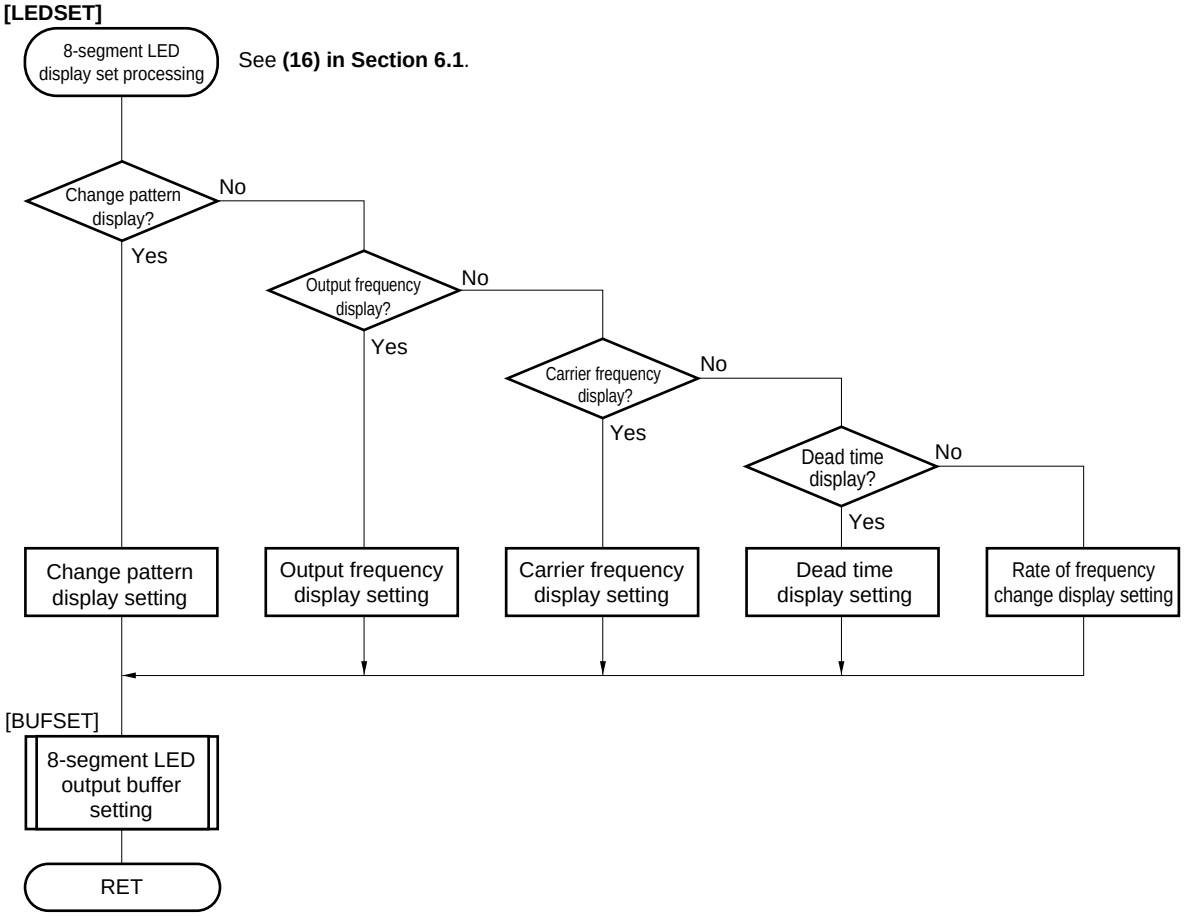
[OUTST]



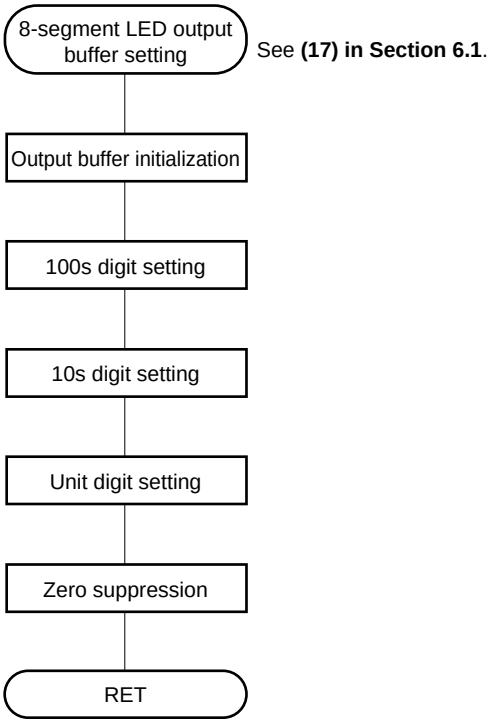
[WAITSET]

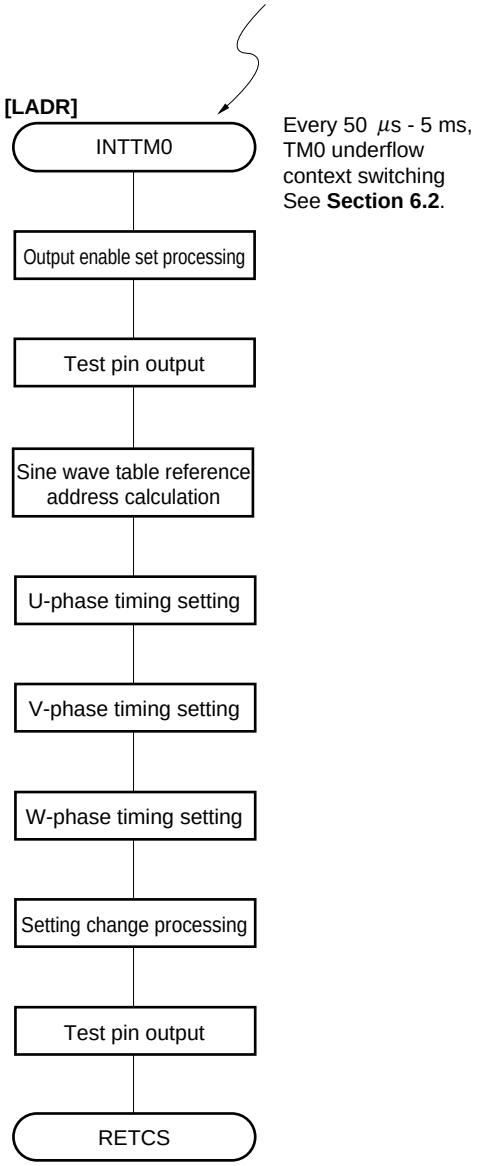


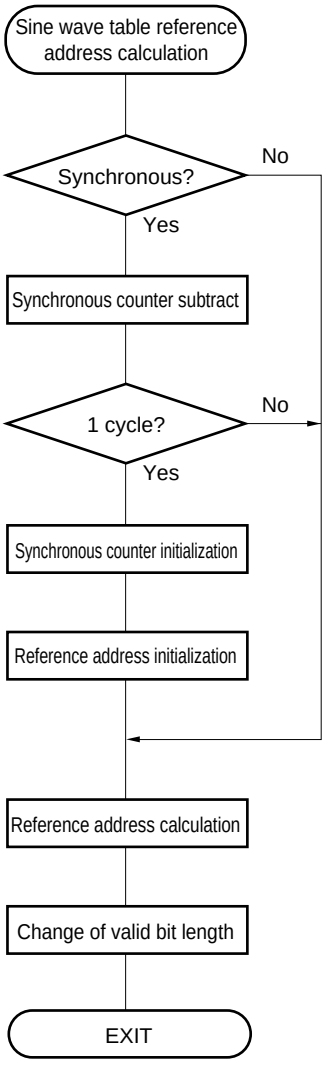
[LEDSET]

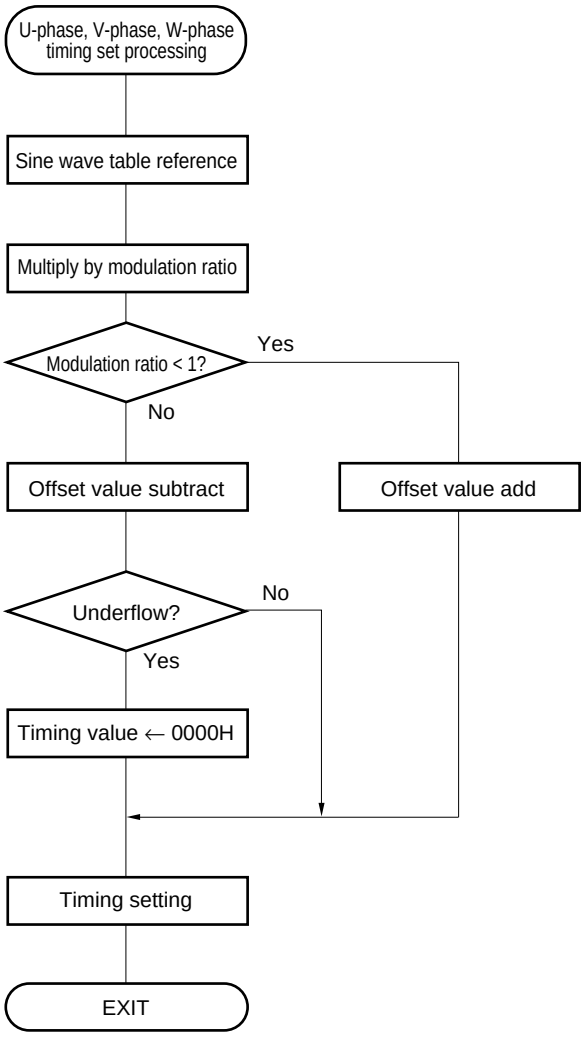


[BUFSET]









CHAPTER 6 PROGRAM LIST

This chapter lists programs of this application software.

6.1 MAIN PROCESSING

```
$PC(366A)
$INCLUDE(AIRINC.INC)                                        ; Constant definition
EXTRN   VFTBL1,   CRRYTBL, CHNGTBL, DEADTBL, FRQTBL    ; Tables
EXTRN   LEDTBL,   FMXTBL,  DMXTBL,  PTNTBL,  CHDSPTBL  ; Tables
EXTRN   LADR,     NMISTP                                ; Interrupts
PUBLIC  BVF,      VF,      BSADR,   SADR                ; saddr variables
PUBLIC  BCRYCNT,  CRYCNT,  BOFFSET, OFFSET              ; saddr variables
PUBLIC  WCRYCNT,  BDTIME,  RFOUT,   TM0CNT,  BCM03     ; saddr variables
PUBLIC  _CHNGST,  _SYNC,   _BSVF,   _SVF                ; Flags
```

(1) Variable definition

```
IRAM      DSEG SADDR       ;************ Variable definition
PMODE:    DS 1     ; Main mode
RFOUT:    DS 1     ; Target frequency
NFOUT:    DS 1     ; Output frequency
NCRRY:    DS 1     ; Carrier frequency
NDEAD:    DS 1     ; Dead time
NCHNG:    DS 1     ; Change rate
NPTRN:    DS 1     ; Change pattern
NSET:     DS 1     ; Set number
NSETMN:   DS 1     ; Maximum value for set number
NSETMX:   DS 1     ; Minimum value for set number
SFOUT:    DS 1     ; Carrier frequency buffer
KIN:      DS 1     ; Port input pattern
SMODE:    DS 1     ; Key input setting mode
DMODE:    DS 1     ; 8-segment LED display mode
WAITCNT:  DS 2     ; Wait counter

BSADR:    DS 2     ; Step address buffer
BVF:      DS 2     ; Modulation ratio buffer
BCM03:    DS 2     ; CM03 buffer
BCRYCNT:  DS 2     ; Carrier wave counter buffer
BOFFSET:  DS 2     ; V/f offset revision value buffer

SADR:     DS 2     ; Step address
SIN:      DS 2     ; Sine wave operation variable
CRRY:     DS 2     ; Carrier wave counter
VF:       DS 2     ; Modulation ratio
VFP:      DS 2     ; V/f modulation ratio data pointer
PTNP:     DS 2     ; Change pattern data pointer
OFFSET:   DS 2     ; V/f offset revision value

BDTIME:   DS 2     ; Dead time counter
WCRYCNT:  DS 2     ;
CRYCNT:   DS 2     ;
SEGBUF:   DS 3     ; 8-segment LED display buffer
SEGCNT:   DS 1     ; 8-segment LED flash counter
LEDCNT:   DS 1     ; LED flash counter
KSMPCNT:  DS 1     ; Key input sampling counter
KONCNT:   DS 1     ; Hold-down counter
KCODE1:   DS 1     ; Key code buffer 1
KCODE2:   DS 1     ; Key code buffer 2
PSMPCNT:  DS 1     ; Stop signal sampling counter
TM0CNT:   DS 1     ; INTTM0 interrupt counter
```

```
FLAG    BSEG UNIT
_CHNGST DBIT    ; Frequency change request
_LEDOUT DBIT    ; LED output
_MINIT  DBIT    ; PWM mode initialization
_PCHNG  DBIT    ; PWM variable change
_PTNOUT DBIT    ; Change pattern output
_SYNC   DBIT    ; Synchronous/asynchronous

FLAG1   BSEG UNIT
_SVF    DBIT    ; V/f modulation ratio (0:  Modulation ratio < 1)
_BSVF   DBIT    ; V/f modulation ratio buffer

STK     DSEG AT 0FE6CH   ;************ Stack definition
        DS 20            ; Stack area
STACK:
;
```

(2) Vector table definition

```
VECTR  CSEG AT 0000H     ;************ Vector table definition
DW     START             ; Main routine (RB0)
DW     NMISTP            ; NMI vectored interrupt (RB5)
DW             START     ; INTWDT    (not used)
DW             START     ; INTOV3    (not used)
DW             START     ; INTP0     (not used)
DW             START     ; INTP1     (not used)
DW             START     ; INTP2     (not used)
DW             START     ; INTP3     (not used)
DW             START     ; INTP4     (not used)
DW     7                 ; INTTM0 context switching (RB7)
DW             START     ; INTCM03   (not used)
DW             START     ; INTCM10   (not used)
DW             START     ; INTCM40   (not used)
DW             START     ; INTCM41   (not used)
DW             START     ; INTSER    (not used)
DW             START     ; INTSR     (not used)
DW             START     ; INTCSI    (not used)
DW             START     ; INTAD     (not used)
```

(3) Initialization

```
CODE    CSEG
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
        ;SS          Initialization                    SS
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
START:
        MOV     MM,#01000001B     ; Port 4:  Output
        MOVW    PWC,#0FFH
        MOVW    SP,#STACK         ; Stack setting
        MOV     PMC0,#0           ; P0:  Port
        MOV     PM0,#01111110B    ; P0:  Only P07 fixed to output
        MOV     P0,#01            ; P0 output latch setting
        MOV     PM1,#11111111B    ; P1:  Not used (VSS input)
        MOV     P1,#0             ; P1 output latch setting
        MOV     PMC3,#0           ; P3:  Port
        MOV     PM3,#01111111B    ; P3:  Not used (VSS input)
        MOV     P3,#0             ; P3 output latch setting
        MOV     PM5,#11110000B    ; P5:  I/O
        MOV     P5,#1             ; P5 output latch setting
        MOV     PMC8,#00111111B   ; P8:  Real-time output
        MOV     PM8,#00000000B    ; P8:  Output
        MOV     P8,#00111111B     ; P8 output latch setting
        MOV     PM9,#00001011B    ; P9:  I/O
        MOV     P9,#0             ; P9 output latch setting

RAMCLR:         ;************ RAM clear
        MOVW    DE,#0FEEFH              ; Start address
        MOV     A,#0                    ; Clear data
        MOV     C,#0EFH
        MOVM    [DE-],A                 ; FE00H - FEEFH   clear
        MOVM    [DE-],A                 ; FD00H - FDFFH   clear
        MOVM    [DE-],A                 ; FC00H - FCFFH   clear
        MOVM    [DE-],A                 ; FB00H - FBFFH   clear
        MOVM    [DE-],A                 ; FA00H - FAFFH   clear
        MOVM    [DE-],A                 ; F900H - F9FFH   clear
        MOVM    [DE-],A                 ; F800H - F8FFH   clear
        MOVM    [DE-],A                 ; F700H - F7FFH   clear

        MOV     PMODE,#PMSTOP           ; Main mode:  Output stop
        MOV     DMODE,#DMPTRN           ; Display mode:  Change pattern
        MOV     SMODE,#SMPTN            ; Setting mode:  Change pattern
        MOV     NSETMX,#10              ; Change pattern upper limit
        MOV     NSETMN,#1               ; Change pattern lower limit
        MOV     NSET,#1                 ; Initial set number:  1
        MOV     NFOUT,#FRQSTOP          ; Output frequency:  Stop
        MOV     RFOUT,#FRQSTOP          ; Target frequency:  Stop
        MOV     KSMPCNT,#3              ; Key input sampling counter setting
        MOV     PSMPCNT,#1              ; Stop signal sampling counter setting
        MOV     SEGCNT,#80H+SEGINI      ; 8-segment LED flash counter setting
        MOV     LEDCNT,#80H+LEDINI      ; LED flash counter setting
        MOV     SEGBUF,#CHRSPC          ; 8-segment LED display buffer 1:  " "
        MOV     SEGBUF+1,#CHRSPC        ; 8-segment LED display buffer 2:  " "
        MOV     SEGBUF+2,#CHRSPC        ; 8-segment LED display buffer 3:  " "
```

```
        MOV     TMC0,#00010000B         ; Timer 0:  fCLK selected, direct write enabled
        MOV     TUM0,#01000010B         ; Symmetrical sawtooth wave for RPU (stopped)
        MOVW    PCSTK7,#LADR            ; INTTM0 PC setting
        SET1    TMIC0.4                 ; INTTM0 context switching
        EI
        MOVW    CM10,#MLWAIT            ;
        MOV     TMC1,#8AH               ; Dead time timer enable
INISET3:        ;************ Synchronous/asynchronous selection input
        MOV1    CY,P9.0                 ; Port input (first time)
        MOV1    _SYNC,CY
        MOV     B,#0                    ; Wait
INISET4:
        DBNZ    B,$INISET4
        XOR1    CY,P9.0                 ; Port input (second time)
        BC      $INISET3
                ;************ Initial dead time (lower limit) setting
        MOV     NDEAD,#DEADMN1
```

(4) Main loop

```
MLOOP:          ;************ Main loop
        BF      CMIF10,$MLOOP
        CLR1    CMIF10
        CALL    !LEDOUT                 ; LED and 8-segment LED output processing
        CALL    !KEYIN                  ; Key input processing
        CALL    !KEYSET                 ; Key setting
        CALL    !SMCHNG                 ; Setting mode transition processing
        CALL    !PMSET                  ; Main mode transition processing
        SET1    P0.7
        CALL    !INVSET                 ; Inverter output setting
        CLR1    P0.7
        CALL    !LEDSET                 ; LED and 8-segment LED display setting
        BR      $MLOOP
```

(5) PWM mode transition processing

```
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
        ;SS      PWM mode transition processing      SS
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
PMSET:          ;************ ; Branch for stop mode
        CMP     PMODE,#PMSTOP
        BNE     $PMSET2
PMSET0:
        MOV1    CY,P2.0         ; Stop signal input (first time)
        MOV1    A.0,CY
        MOV     B,#1
PMSETW1:
        DBNZ    B,$PMSETW1
        XOR1    CY,P2.0         ; Stop signal input (second time)
        BC      $PMSET0
        BF      A.0,$PMSET1     ; Stop signal active?
        CMP     RFOUT,#FRQSTOP  ; Frequency stop setting?
        BE      $PMSET1
        MOV     PMODE,#PMCHNG
        SET1    _MINIT
        BR      $PMSET6
PMSET1:
        CLR1    _MINIT
        BR      $PMSET6
PMSET2:         ;************ Branch for output mode
        MOV1    CY,P2.0         ; Stop signal input (first time)
        MOV1    A.0,CY
        MOV     B,#1
PMSETW2:
        DBNZ    B,$PMSETW2
        XOR1    CY,P2.0         ; Stop signal input (second time)
        BC      $PMSET2
        BT      A.0,$PMSET4
PMSET3:         ;************ Stop according to stop signal
        MOV     PMODE,#PMSTOP   ; Stop mode setting
        SET1    _MINIT
        BR      $PMSET6
PMSET4:
        CMP     RFOUT,#FRQSTOP  ; Stop setting?
        BE      $PMSET3
        CMP     PMODE,#PMFOUT
        BNE     $PMSET5
        CMP     RFOUT,NFOUT
        BE      $PMSET1
        MOV     PMODE,#PMCHNG
        SET1    _MINIT
        BR      $PMSET6
PMSET5:
        CMP     RFOUT,NFOUT
        BNE     $PMSET1
        MOVW    WAITCNT,#0
        BNE     $PMSET1
        MOV     PMODE,#PMFOUT
        SET1    _MINIT
PMSET6:
        RET
```

(6) Key setting

```
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
        ;SS      Key setting                    SS
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
KEYSET:         ;************ [ON/OFF] key setting
        CMP     KCODE2,#KONOF       ; [ON/OFF] key pressed?
        BNE     $KEYSET1
        CMP     KCODE1,KCODE2
        BE      $KEYSET6
        CMP     SMODE,#SMOFF
        BE      $KEYSET7
        CALL    !PSET               ; Set value store subroutine
        BR      $KEYSET6
KEYSET7:
        CMP     PMODE,#PMSTOP
        BE      $KEYSET10
        MOV     RFOUT,#FRQSTOP
        BR      $KEYSET6
KEYSET10:
        MOV     RFOUT,SFOUT
        BR      $KEYSET6
KEYSET1:        ;************ [Changeover] key setting
        CMP     KCODE2,#KCHNG       ; [Changeover] key pressed?
        BNE     $KEYSET3
        CMP     KCODE1,KCODE2
        BE      $KEYSET6
        CMP     SMODE,#SMOFF
        BE      $KEYSET2
        CALL    !PCLR               ; Set value clear subroutine
        BR      $KEYSET6
KEYSET2:
        CALL    !DCHNG
        BR      $KEYSET6
KEYSET3:        ;************ [+], [-] key setting
        BF      KCODE2.1,$KEYSET6
        CMP     KCODE1,KCODE2
        BE      $KEYSET4
        MOV     KONCNT,#KONINI
        BR      $KEYSET5
KEYSET4:
        BF      DMODE.4,$KEYSET6
        DBNZ    KONCNT,$KEYSET6
        MOV     KONCNT,#KONRES
KEYSET5:
        MOV     SEGCNT,#80H+SEGINI
        CALL    !PCHNG              ; Set value change subroutine
KEYSET6:
        RET
```

(7) Set value store subroutine

```
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
        ;SS      Set value store subroutine              SS
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
PSET:           ;************ Target frequency setting
        CMP     DMODE,#DMFOUT       ; Display target frequency?
        BNE     $PSET1
        MOV     SFOUT,NSET          ; Target frequency setting
        CMP     PMODE,#PMSTOP
        BE      $PSET5
        MOV     RFOUT,NSET
        BR      $PSET5
PSET1:          ;************ Carrier frequency setting
        CMP     DMODE,#DMCRRY       ; Display carrier frequency?
        BNE     $PSET2
        MOV     NCRRY,NSET          ; Carrier frequency setting
        BR      $PSET5
PSET2:          ;************ Dead time setting
        CMP     DMODE,#DMDEAD       ; Display dead time?
        BNE     $PSET3
        MOV     NDEAD,NSET          ; Dead time setting
        BR      $PSET5
PSET3:          ;************ Setting of rate of frequency change
        CMP     DMODE,#DMCHNG       ; Display rate of frequency change?
        BNE     $PSET4
        MOV     NCHNG,NSET          ; Setting of rate of frequency change
        BR      $PSET5
PSET4:          ;************ Change pattern setting
        MOV     NPTRN,NSET          ; Change pattern setting
        DEC     NPTRN
        MOV     DMODE,#DMFOUT       ; Display output frequency after setting
        MOV     A,NPTRN
        ADD     A,A
        MOVW    AX,PTNTBL[A]        ; Change pattern start address reference
        MOVW    HL,AX
        MOV     A,[HL+]             ; Pattern table reference
        MOV     NSET,A
        MOV     SFOUT,A             ; Target frequency initialization
        MOV     NSETMN,A            ; Target frequency lower limit setting
        MOV     A,[HL+]             ; Change pattern table reference
        MOV     NCRRY,A             ; Carrier frequency initialization
        MOV     A,FMXTBL[A]
        MOV     NSETMX,A
        MOV     A,[HL+]             ; Reference pattern table
        MOV     NCHNG,A             ; Initialization of rate of frequency change
PSET5:
        CMP     PMODE,#PMSTOP
        BE      $PSET6
        SET1    _PCHNG
PSET6:
        RET
```

(8) Set value clear subroutine

```
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
        ;SS      Set value clear subroutine              SS
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
PCLR:           ;************ Target frequency setting clear processing
        CMP     DMODE,#DMFOUT       ; Target frequency display?
        BNE     $PCLR1
        MOV     NSET,SFOUT          ; Target frequency setting clear
        BR      $PCLR4
PCLR1:          ;************ Carrier frequency setting clear processing
        CMP     DMODE,#DMCRRY       ; Carrier frequency display?
        BNE     $PCLR2
        MOV     NSET,NCRRY          ; Carrier frequency setting clear
        BR      $PCLR4
PCLR2:          ;************ Dead time setting clear processing
        CMP     DMODE,#DMDEAD       ; Display dead time?
        BNE     $PCLR3
        MOV     NSET,NDEAD          ; Dead time setting clear
        BR      $PCLR4
PCLR3:          ;************ Setting clear processing for rate of frequency change
        CMP     DMODE,#DMCHNG       ; Display rate of frequency change?
        BNE     $PCLR4
        MOV     NSET,NCHNG          ; Clear setting made for rate of frequency change
PCLR4:
        RET
```

(9) Set value change subroutine

```
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
        ;SS      Set value change subroutine              SS
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
PCHNG:          ;************ Changing set value other than carrier frequency
        CMP     DMODE,#DMCRRY
        BE      $PCHNG2
        CMP     KCODE2,#KPLUS
        BNE     $PCHNG1
                ;************ [+] key processing
        CMP     NSET,NSETMX         ; Maximum set value?
        BE      $PCHNG4
        ADD     NSET,#1             ; Increase set value
        BR      $PCHNG4
PCHNG1:         ;************ [-] key processing
        CMP     NSET,NSETMN         ; Minimum set value?
        BE      $PCHNG4
        SUB     NSET,#1             ; Reduce set value
        BR      $PCHNG4
PCHNG2:         ;************ Changing set value of carrier frequency
        CMP     KCODE2,#KPLUS
        BNE     $PCHNG3
                ;************ [+] key processing
        CMP     NSET,NSETMX         ; Maximum set value?
        BE      $PCHNG4
        MOV     A,NSET
        INC     A
        MOV     A,DMXTBL[A]
        CMP     A,NDEAD
        BL      $PCHNG4
        INC     NSET
        BR      $PCHNG4
PCHNG3:         ;************ [-] key processing
        CMP     NSET,NSETMN         ; Minimum set value?
        BE      $PCHNG4
        MOV     A,NSET
        DEC     A
        MOV     A,FMXTBL[A]
        CMP     A,SFOUT
        BL      $PCHNG4
        DEC     NSET
PCHNG4:
        RET
```

(10) Display changeover processing

```
        ;sssssssssssssssssssssssssssssssssssssssss
        ;ss      Display changeover processing          ss
        ;sssssssssssssssssssssssssssssssssssssssss
DCHNG:          ;************ Target frequency to carrier frequency
        CMP     DMODE,#DMFOUT       ; Display target frequency?
        BNE     $DCHNG1
        MOV     DMODE,#DMCRRY       ; Carrier frequency display setting
        MOV     NSETMX,#100         ; Upper limit setting
        MOV     NSETMN,#1           ; Lower limit setting
        MOV     NSET,NCRRY
        BR      DCHNG4
DCHNG1:         ;************ Carrier frequency to dead time
        CMP     DMODE,#DMCRRY       ; Display carrier frequency?
        BNE     $DCHNG2
        MOV     DMODE,#DMDEAD       ; Dead time display setting
        MOV     A,NCRRY
        MOV     A,DMXTBL[A]
        MOV     NSETMX,A            ; Upper limit setting
        MOV     NSETMN,#DEADMN1
        MOV     NSET,NDEAD
        BR      DCHNG4
DCHNG2:         ;************ Dead time to rate of frequency change
        CMP     DMODE,#DMDEAD       ; Display dead time?
        BNE     $DCHNG3
        MOV     DMODE,#DMCHNG       ; Display setting for rate of frequency change
        MOV     NSETMX,#3           ; Upper limit setting
        MOV     NSETMN,#0           ; Lower limit setting
        MOV     NSET,NCHNG
        BR      $DCHNG4
DCHNG3:         ;************ Rate of frequency change to target frequency
        MOV     DMODE,#DMFOUT       ; Target frequency display setting
        MOV     A,NCRRY
        MOV     A,FMXTBL[A]
        MOV     NSETMX,A            ; Upper limit setting
        MOV     A,NPTRN
        ADD     A,A
        MOVW    AX,PTNTBL[A]        ; Change pattern start address reference
        MOVW    HL,AX
        MOV     A,[HL]              ; Change pattern table reference
        MOV     NSETMN,A            ; Lower limit setting
        MOV     NSET,SFOUT
DCHNG4:
        RET
```

(11) Key input processing

```
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
        ;SS      Key input processing                SS
        ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
KEYIN:
        MOV     KCODE1,KCODE2
        DBNZ    KSMPCNT,$KEYIN8
        MOV     KSMPCNT,#KSMPINI
        MOV     A,P5
        MOV     B,#2
KEYIN1:
        DBNZ    B,$KEYIN1
        CMP     A,P5
        BNE     $KEYIN7
        XOR     A,#0FFH
        AND     A,#0F0H
        MOV     X,A
        AND     A,KIN
        BZ      $KEYIN5
        BF      A.4,$KEYIN2
        MOV     KCODE2,#KONOF
        BR      $KEYIN6
KEYIN2:
        BF      A.5,$KEYIN3
        MOV     KCODE2,#KPLUS
        BR      $KEYIN6
KEYIN3:
        BF      A.6,$KEYIN4
        MOV     KCODE2,#KMINS
        BR      $KEYIN6
KEYIN4:
        MOV     KCODE2,#KCHNG
        BR      $KEYIN6
KEYIN5:
        MOV     A,X
        OR      A,KIN
        BNZ     $KEYIN6
        MOV     KCODE2,#KNULL
KEYIN6:
        MOV     A,X
        MOV     KIN,A
        BR      $KEYIN8
KEYIN7:
        MOV     KCODE2,#KERR
KEYIN8:
        RET
```

(12) Setting mode transition processing

```
          ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
          ;SS       Setting mode transition processing        SS
          ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
SMCHNG:
          CMP      KCODE1,KCODE2
          BE       $SMCHNG4
          CMP      SMODE,#SMOUT
          BNE      $SMCHNG2
          CMP      KCODE2,#KONOF
          BE       $SMCHNG1
          CMP      KCODE2,#KCHNG
          BE       $SMCHNG1
          MOV      SMODE,#SMOUT
          BR       $SMCHNG4
SMCHNG1:
          MOV      SMODE,#SMOFF
          BR       $SMCHNG4
SMCHNG2:
          CMP      SMODE,#SMPTN
          BE       $SMCHNG3
          BF       KCODE2.1,$SMCHNG4
          MOV      SMODE,#SMOUT
          BR       $SMCHNG4
SMCHNG3:
          CMP      KCODE2,#KONOF
          BNE      $SMCHNG4
          MOV      SMODE,#SMOFF
          MOV      DMODE,#DMFOUT
SMCHNG4:
          RET
```

(13) Inverter output setting

```
          ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
          ;SS       Inverter output setting                    SS
          ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
INVSET:
          BF       _MINIT,$INVSET5
          CMP      PMODE,#PMSTOP
          BNE      $INVSET1
                   ;************ Initialization for stop mode
          SET1     TUM0.1              ; Prohibit output
          SET1     TMIC0.6             ; Prohibit INTTM0
          CLR1     TMC0.7              ; TM0 count stop
          SET1     P0.0                ; Output enable signal setting
          MOV      NFOUT,#FRQSTOP      ; Output frequency stop setting
          MOV      RFOUT,#FRQSTOP      ; Target frequency stop setting
          BR       !INVSET8
INVSET1:
          CMP      PMODE,#PMCHNG
          BNE      $INVSET8
                   ;************ Initialization for change mode
          CMP      NFOUT,#FRQSTOP
          BNE      $INVSET3
                   ;************ Output start processing
          SET1     _PTNOUT             ; Change pattern output setting
          MOV      A,NPTRN
          ADD      A,A
          MOVW     AX,PTNTBL[A]
          MOVW     PTNP,AX
          MOV      NFOUT,#FOUTINI      ; Output frequency setting
          MOVW     VFP,#VFPINI         ; V/f modulation ratio pointer setting
          CALL     !FRQCNG             ; Variable buffer setting
          CALL     !WAITSET
          CALL     !OUTST              ; Output start processing
          CLR1     P0.0                ; Output enable signal setting
          BR       $INVSET8
INVSET3:          ;************ Output frequency setting change
          CMP      NFOUT,RFOUT
          BL       $INVSET4
          DEC      NFOUT               ; Reduce output frequency
          SUBW     VFP,#2              ; Reduce V/f modulation ratio pointer
          BR       $INVSET6
INVSET4:
          INC      NFOUT               ; Increase output frequency
          ADDW     VFP,#2              ; Increase V/f modulation ratio pointer
          BR       $INVSET6
INVSET5:          ;************ Frequency change mode processing
          CMP      PMODE,#PMCHNG
          BNE      $INVSET10
          CMPW     WAITCNT,#0
          BE       $INVSET3
          DECW     WAITCNT
          BTCLR    _PCHNG,$INVSET9
          BR       $INVSET8
```

```
INVSET6:
          CALL   !WAITSET
INVSET9:
          CALL   !FRQCNG             ; Variable buffer setting
          SET1   _CHNGST             ; Change start flag setting
INVSET8:
          RET
INVSET10:       ;************ Fixed-speed output mode processing
          CMP    PMODE,#PMFOUT
          BNE    $INVSET11
          BTCLR  _PCHNG,$INVSET9
          BR     $INVSET8
INVSET11:       ;************ Stop mode processing
          MOV    RFOUT,#FRQSTOP
          BR     $INVSET8
```

(14) PWM output start processing

```
         ;sssssssssssssssssssssssssssssssssssssss
         ;ss      PWM output start processing              ss
         ;sssssssssssssssssssssssssssssssssssssss
OUTST:
;        SET1    _CHNGST            ; Change start flag setting
         MOVW    CRYCNT,BCRYCNT     ; Carrier wave counter transfer
         MOVW    WCRYCNT,CRYCNT
         MOVW    VF,BVF             ; V/f modulation ratio transfer
         MOVW    SADR,BSADR         ; Step address transfer
         MOVW    OFFSET,BOFFSET     ; V/f offset revision value transfer
         MOVW    TM0WADR,#00H       ; Address operation variable setting
         MOV1    CY,_BSVF
         MOV1    _SVF,CY            ; V/f modulation ratio flag transfer
         MOVW    AX,BCM03
         MOVW    CM03,AX            ; Carrier frequency change
         SHRW    AX,1               ; CM03/2
         MOVW    BFCM00,AX          ; Buffer register initialization
         MOVW    BFCM01,AX
         MOVW    BFCM02,AX
         MOVW    AX,BDTIME          ; Dead time change
         MOVW    DTIME,AX

         MOVW    CM00,#0FFFFH       ; U-phase switching avoidance
         MOVW    CM01,#0FFFFH       ; V-phase switching avoidance
         MOVW    CM02,#0FFFFH       ; W-phase switching avoidance
         MOV     TM0CNT,#01H
         MOV     TUM0,#01000010B    ; RPU mode setting
         CLR1    TMIC0.7            ; INTTM0 interrupt request clear
         CLR1    TMIC0.6
         SET1    TMC0.7             ; TM0 operation setting
         RET
```

(15) LED and 8-segment LED output processing

```
          ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
          ;SS     LED and 8-segment LED output processing  SS
          ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
LEDOUT:
          MOV     A,P5                ;
          MOV     P5,#0               ; Digit output stop
          MOV     P4,#0               ; Pattern output stop
          SHR     A,1
          MOV1    A.2,CY
          MOV1    CY,_LEDOUT
          AND1    CY,LEDCNT.7
          MOV1    A.3,CY              ; LED output setting
          MOV     P5,A                ; Digit output start
          BF      SEGCNT.7,$LEDOUT1
          AND     A,#7
          SHR     A,1
          MOV     A,SEGBUF[A]         ; Display buffer reference
          MOV     A,LEDTBL[A]         ; Display pattern reference
          MOV     P4,A                ; Pattern output start
LEDOUT1:
          RET
```

(16) LED and 8-segment LED display setting

```
          ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
          ;SS     LED and 8-segment LED display setting       SS
          ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
LEDSET:         ;************ Output frequency display setting
          CMP     SMODE,#SMPTN
          BE      $LEDSET90
          CMP     DMODE,#DMFOUT
          BNE     $LEDSET3
          CMP     SMODE,#SMOFF
          BNE     $LEDSET1
          CMP     PMODE,#PMCHNG
          BE      $LEDSET30
          MOV     A,SFOUT
          BR      $LEDSET2
LEDSET30:
          MOV     A,NFOUT
          BR      $LEDSET2
LEDSET90:
          BR      $LEDSET12
LEDSET1:
          MOV     A,NSET
LEDSET2:
          MOV     A,FRQTBL[A]
          CALL    !BUFSET               ; 8-segment LED display buffer setting
          BR      $LEDSET13
LEDSET3:        ;************ Carrier frequency display setting
          CMP     DMODE,#DMCRRY
          BNE     $LEDSET6
          CMP     SMODE,#SMOFF
          BNE     $LEDSET4
          MOV     A,NCRRY
          BR      $LEDSET5
LEDSET4:
          MOV     A,NSET
LEDSET5:
          ADD     A,A
          MOVW    AX,CRRYTBL[A]
          MOV     R2,#100
          DIVUW   R2
          MOV     A,X
          CALL    !BUFSET               ; 8-segment LED display buffer setting
          CMP     SEGBUF+1,#CHRSPC      ; Less than 1.0?
          BE      $LEDSET50
          ADD     SEGBUF+1,#10H         ; Add decimal point
          BR      $LEDSET13
LEDSET50:
          MOV     SEGBUF+1,#CHRZ        ; Set "0."
          BR      $LEDSET13
LEDSET6:        ;************ Dead time display setting
          CMP     DMODE,#DMDEAD
          BNE     $LEDSET9
          CMP     SMODE,#SMOFF          ; Setting mode off?
          BNE     $LEDSET7
          MOV     A,NDEAD
          BR      $LEDSET8
```

```
LEDSET7:
          MOV    A,NSET
LEDSET8:
          MOV    A,DEADTBL[A]
          CALL   !BUFSET              ; 8-segment LED display buffer setting
          MOV    SEGBUF,#CHRD         ; Set "d"
          BR     $LEDSET13
LEDSET9:  ;************ Change rate display setting
          CMP    SMODE,#SMOFF
          BNE    $LEDSET10
          MOV    A,NCHNG
          BR     $LEDSET11
LEDSET10:
          MOV    A,NSET
LEDSET11:
          MOV    A,CHDSPTBL[A]
          CALL   !BUFSET              ; 8-segment LED display buffer setting
          MOV    SEGBUF,#CHRO         ; Set "o"
          CMP    SEGBUF+1,#CHRSPC
          BE     $LEDSET60
          ADD    SEGBUF+1,#10H        ; Add decimal point
          BR     $LEDSET13
LEDSET60:
          MOV    SEGBUF+1,#CHRZ
          BR     $LEDSET13
LEDSET12: ;************ Change pattern display setting
          MOV    A,NSET
          CALL   !BUFSET              ; 8-segment LED display buffer setting
          CMP    SEGBUF+1,#CHRSPC
          BNE    $LEDSET40
          MOV    SEGBUF+1,#0
LEDSET40:
          MOV    SEGBUF,#CHRP         ; Set "P"
LEDSET13: ;************ LED flash counter setting
          CMP    PMODE,#PMSTOP
          BNE    $LEDSET17
          CLR1   _LEDOUT
          BR     $LEDSET14
LEDSET17:
          CMP    PMODE,#PMCHNG
          BNE    $LEDSET18
          DEC    LEDCNT
          CMP    LEDCNT,#80H-LEDINI
          BNE    $LEDSET19

LEDSET18:
          MOV    LEDCNT,#80H+LEDINI
LEDSET19:
          MOV1   CY,LEDCNT.7
          MOV1   _LEDOUT,CY
LEDSET14: ;************ 8-segment LED flash counter setting
          CMP    SMODE,#SMOFF
          BE     $LEDSET16
          DEC    SEGCNT
          CMP    SEGCNT,#80H-SEGINI
          BNE    $LEDSET15
```

```
          MOV    SEGCNT,#80H+SEGINI
          BR     $LEDSET15
LEDSET16:
          MOV    SEGCNT,#80H+SEGINI
LEDSET15:
          RET
```

(17) 8-segment LED output buffer setting

```
          ;sssssssssssssssssssssssssssssssssssssssss
          ;ss    8-segment LED output buffer setting        ss
          ;sssssssssssssssssssssssssssssssssssssssss
BUFSET:         ;************ Initialization, third digit setting
          MOV    SEGBUF,#0            ; Set "0"
          MOV    SEGBUF+1,#0          ; Set "0"
BUFSET1:        ;************ First digit setting
          CMP    A,#100
          BL     $BUFSET2
          INC    SEGBUF
          SUB    A,#100
          BR     $BUFSET1
BUFSET2:        ;************ Second digit setting
          CMP    A,#10
          BL     $BUFSET3
          INC    SEGBUF+1
          SUB    A,#10
          BR     $BUFSET2
BUFSET3:        ;************ Leading zero deletion
          CMP    SEGBUF,#0
          BNE    $BUFSET4
          MOV    SEGBUF,#CHRSPC
          CMP    SEGBUF+1,#0
          BNE    $BUFSET4
          MOV    SEGBUF+1,#CHRSPC
BUFSET4:        ;************ First digit setting
          MOV    SEGBUF+2,A
          RET
```

(18) Frequency setting change processing

```
          ;sssssssssssssssssssssssssssssssssssssssss
          ;ss      Frequency setting change processing      ss
          ;sssssssssssssssssssssssssssssssssssssssss
FRQCNG:           ;********** Change pattern setting
          BF      _PTNOUT,$FRQCNG01
          MOVW    AX,PTNP
          MOVW    HL,AX
          MOV     A,NFOUT
          CMP     A,[HL+3]
          BNE     $FRQCNG0
          ADDW    PTNP,#3
          MOVW    AX,PTNP
          MOVW    HL,AX
FRQCNG0:
          MOV     A,#0FFH
          CMP     A,[HL+1]
          BNE     $FRQCNG01
          CLR1    _PTNOUT
FRQCNG01:
                  ;*********** DTIME (dead time) setting
          MOV     A,NDEAD
          MOV     A,DEADTBL[A]
          MOV     X,#0
          XCH     A,X
          SHLW    AX,4
          MOVW    BDTIME,AX
                  ;*********** BCM03 (carrier frequency) setting
          BT      _PTNOUT,$FRQCNG1
          MOV     A,NCRRY
          BR      $FRQCNG2
FRQCNG1:
          MOV     A,[HL+1]
FRQCNG2:
          ADD     A,A
          MOVW    AX,CRRYTBL[A]
          ADDW    AX,AX
          BF      _SYNC,$FRQCNG5
          MOVW    RP2,AX
          MOV     A,NFOUT
          MOV     A,FRQTBL[A]
          MOV     B,A
          MOV     C,A
          MOVW    AX,RP2
          DIVUW   B
          SHRW    AX,1
          BNC     $FRQCNG3
          ADDW    AX,#1
FRQCNG3:
          SUBW    AX,#1
          MOVW    BCRYCNT,AX
          MOV     B,#0
          MULUW   BC
          MOVW    AX,BC
          ADDW    AX,AX
```

```
FRQCNG5:
          MOVW    RP2,AX
          MOVW    AX,#00F4H
          MOVW    DE,#2400H
          DIVUX   RP2
          MOVW    AX,DE
          MOVW    BCM03,AX
                  ;************ BSADR (step address) setting
          BT      _PTNOUT,$FRQCNG10
          MOV     A,NCRRY
          BR      $FRQCNG11
FRQCNG10:
          MOVW    AX,PTNP
          MOVW    HL,AX
          MOV     A,[HL+1]
FRQCNG11:
          ADD     A,A
          MOVW    AX,CRRYTBL[A]
          MOVW    RP2,AX
          MOV     A,NFOUT
          MOV     X,#0
          XCH     A,X
          MOVW    DE,#0
          DIVUX   RP2
          MOVW    AX,DE
          MOVW    BSADR,AX
                  ;************ BVF (modulation ratio buffer) setting
          MOVW    AX,BCM03
          MOVW    RP2,AX
          MOVW    AX,VFP
          MOVW    HL,AX
          MOVW    AX,VFTBL1[HL]
          CLR1    _BSVF
          CMP     A,#10H              ; V/f modulation ratio < 0?
          BC      $FRQCNG20           ; THEN [Next]
          SET1    _BSVF               ; ELSE [_BSVF set]
FRQCNG20:
          MULUW   RP2
          SHLW    AX,4
          SHR     R5,4
          ADD     X,R5
          MOVW    BVF,AX
          DECW    BCM03
          DECW    BDTIME
                  ;************ BOFFSET (V/f offset revision value) setting
          MOVW    AX,BCM03
          SHRW    AX,1                ; CM03/2
          MOVW    DE,AX
          MOVW    RP2,AX
          MOVW    AX,BVF
          SHRW    AX,1                ; VF/2
          CMPW    AX,DE
          BNC     $FRQCNG30
          XCHW    AX,DE
```

```
FRQCNG30:
          SUBW     AX,DE                ; Offset revision value = |VF/2 - CM03/2|
          MOVW     BOFFSET,AX
          RET
```

(19) Wait setting

```
WAITSET:
          BT       _PTNOUT,$WAITSET1
          MOV      A,NCHNG
          ADD      A,A
          MOVW     AX,CHNGTBL[A]
          MOVW     WAITCNT,AX           ; Wait counter setting
          BR       $WAITSET2
WAITSET1:
          MOVW     AX,PTNP
          MOVW     HL,AX
          MOV      A,[HL+2]
          ADD      A,A
          MOVW     AX,CHNGTBL[A]
          MOVW     WAITCNT,AX           ; Wait counter setting
WAITSET2:
          RET

          END
```

6.2 INTERRUPT PROCESSING

```
$PC(366A)
$INCLUDE(AIRINC.INC)                                    ; Constant definition
EXTRN   SINTBL                                          ; Table
EXTRN   BVF,     VF,       BSADR,    SADR               ; saddr variables
EXTRN   BCM03,   BCRYCNT,  BOFFSET,  OFFSET             ; saddr variables
EXTRN   BDTIME,  WCRYCNT,  CRYCNT,   RFOUT, TM0CNT
EXTBIT  _CHNGST, _SYNC,    _BSVF,    _SVF                ; Flags
PUBLIC  LADR,    NMISTP                                 ; Interrupts


CODE    CSEG
        ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
        ;II      NMI vectored interrupt (using RB5)      II
        ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
NMISTP:
        SEL      RB5                ; Register bank setting
NMISTP1:
        MOV1     CY,P9.1            ; Stop signal input (first time)
        MOV1     A.0,CY
        MOV      B,#1
NMIW1:
        DBNZ     B,$NMIW1
        XOR1     CY,P9.1            ; Stop signal input (second time)
        BC       $NMISTP1           ; Matching?
        BT       A.0,$NMISTP3       ; Error signal active?
        SET1     TUM0.1             ; Stop setting
        MOV      RFOUT,#0FFH        ; Target frequency:  Stop setting
NMISTP3:
        RETI

        ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
        ;II      INTTM0 context switching (using RB7)    II
        ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
LADR:           ;************ Output enable setting
        BT       TM0CNT.7,$LADR0
        SUB      TM0CNT,#1
        NOT1     CY
        MOV1     TUM0.1,CY
LADR0:          ;************ Test pin output processing
        MOV1     CY,P0.7
        MOV1     PSWH.7,CY
        SET1     P0.7
        BF       _SYNC,$LADR1
                 ;************ Table reference address calculation
        SUBW     WCRYCNT,#1         ; One sign wave period elapsed?
        BNL      $LADR1
        MOVW     WCRYCNT,CRYCNT
        MOVW     HL,#0              ; Reference address reset
        MOVW     DE,#0
        MOVW     AX,#0
        BR       $LUADR
```

```
LADR1:          ;************ Reference address operation processing
        MOVW    AX,HL
        ADDW    AX,SADR
        MOVW    HL,AX
        SHRW    AX,4
        ADDW    AX,AX
        MOVW    DE,AX
LUADR:          ;************ U-phase timing setting
        MOVW    AX,VF
        MOVW    RP4,AX
        MOVW    AX,SINTBL[DE]       ; Sine wave table reference
        MULUW   RP4                 ; Multiply by modulation ratio
        BF      _SVF,$LUADR1        ; V/f modulation ratio < 1?
        SUBW    AX,OFFSET           ; ELSE [subtract offset value]
        BNC     $LUSKP
        MOVW    AX,#0000H
        BR      $LUSKP
LUADR1:
        ADDW    AX,OFFSET           ; THEN [add offset value]
LUSKP:
        MOVW    BFCM00,AX           ; Timing setting
LVADR:          ;************ V-phase timing setting
        MOVW    AX,DE
        ADDW    AX,#ADDADR
        AND     A,#11111B
        MOVW    DE,AX
        MOVW    AX,VF
        MOVW    RP4,AX
        MOVW    AX,SINTBL[DE]       ; Sine wave table reference
        MULUW   RP4                 ; Multiply by modulation ratio
        BF      _SVF,$LVADR1        ; V/f modulation ratio < 1?
        SUBW    AX,OFFSET           ; ELSE [subtract offset value]
        BNC     $LVSKP
        MOVW    AX,#0000H
        BR      $LVSKP
LVADR1:
        ADDW    AX,OFFSET           ; THEN [add offset value]
LVSKP:
        MOVW    BFCM01,AX           ; Timing setting
LWADR:          ;************ W-phase timing setting
        MOVW    AX,DE
        ADDW    AX,#ADDADR
        AND     A,#11111B
        MOVW    DE,AX
        MOVW    AX,VF
        MOVW    RP4,AX
        MOVW    AX,SINTBL[DE]       ; Sine wave table reference
        MULUW   RP4                 ; Multiply by modulation ratio
        BF      _SVF,$LWADR1        ; V/f modulation ratio < 1?
        SUBW    AX,OFFSET           ; ELSE [subtract offset value]
        BNC     $LWSKP
        MOVW    AX,#0000H
        BR      $LWSKP
LWADR1:
        ADDW    AX,OFFSET           ; THEN [add offset value]
```

```
LWSKP:
        MOVW    BFCM02,AX           ; Timing setting
LEND:
        BF      _CHNGST,$LADR3
        BF      _SYNC,$LADR2
        CMPW    WCRYCNT,#0
        BNE     $LADR3
LADR2:
        CLR1    _CHNGST             ; Change flag clear
        MOVW    CRYCNT,BCRYCNT      ; Carrier wave counter transfer
        MOVW    VF,BVF              ; V/f modulation ratio transfer
        MOVW    SADR,BSADR          ; Step address transfer
        MOVW    OFFSET,BOFFSET      ; V/f offset revision value transfer
        MOV1    CY,_BSVF
        MOV1    _SVF,CY             ; V/f modulation ratio < 1, flag transfer
        MOVW    AX,BFCM03
        MOVW    CM03,AX             ; Carrier frequency change
        MOVW    AX,BDTIME           ; Dead time change
        MOVW    DTIME,AX
LADR3:          ;************ Test pin output processing
        MOV1    CY,PSWH.7
        MOV1    P0.7,CY
        RETCS   !LADR
        END
```

6.3 TABLE DATA

```
$PC(366A)
PUBLIC  SINTBL,   VFTBL1, FRQTBL,   CRRYTBL, DEADTBL ;Tables
PUBLIC  FMXTBL,   DMXTBL, CHNGTBL, LEDTBL,   PTNTBL  ;Tables
PUBLIC  CHDSPTBL                                     ;Tables
```

(1) Sine wave table

```
TABLE   CSEG
        ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
        ;TT        Sine wave table (4096*2 bytes)          TT
        ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
        ;   Table data = sin(X) * 7FFFH + 7FFFH
SINTBL:
DW      07FFFH,08031H,08064H,08096H,080C8H,080FAH,0812DH,0815FH ;  0.0-  0.7°
DW      08191H,081C3H,081F6H,08228H,0825AH,0828CH,082BFH,082F1H ;  0.7-  1.4°
DW      08323H,08355H,08388H,083BAH,083ECH,0841EH,08451H,08483H ;  1.4-  2.1°
DW      084B5H,084E7H,0851AH,0854CH,0857EH,085B0H,085E2H,08615H ;  2.1-  2.8°
DW      08647H,08679H,086ABH,086DDH,08710H,08742H,08774H,087A6H ;  2.8-  3.5°
DW      087D8H,0880AH,0883DH,0886FH,088A1H,088D3H,08905H,08937H ;  3.5-  4.2°
DW      08969H,0899CH,089CEH,08A00H,08A32H,08A64H,08A96H,08AC8H ;  4.2-  4.9°
DW      08AFAH,08B2CH,08B5EH,08B91H,08BC3H,08BF5H,08C27H,08C59H ;  4.9-  5.6°
DW      08C8BH,08CBDH,08CEFH,08D21H,08D53H,08D85H,08DB7H,08DE9H ;  5.6-  6.3°
DW      08E1BH,08E4DH,08E7FH,08EB0H,08EE2H,08F14H,08F46H,08F78H ;  6.3-  7.0°
DW      08FAAH,08FDCH,0900EH,09040H,09071H,090A3H,090D5H,09107H ;  7.0-  7.7°
DW      09139H,0916BH,0919CH,091CEH,09200H,09232H,09263H,09295H ;  7.7-  8.4°
DW      092C7H,092F9H,0932AH,0935CH,0938EH,093BFH,093F1H,09423H ;  8.4-  9.1°
DW      09454H,09486H,094B8H,094E9H,0951BH,0954CH,0957EH,095AFH ;  9.1-  9.8°
DW      095E1H,09612H,09644H,09675H,096A7H,096D8H,0970AH,0973BH ;  9.8- 10.5°
DW      0976DH,0979EH,097CFH,09801H,09832H,09864H,09895H,098C6H ; 10.5- 11.3°
DW      098F8H,09929H,0995AH,0998BH,099BDH,099EEH,09A1FH,09A50H ; 11.3- 12.0°
DW      09A81H,09AB3H,09AE4H,09B15H,09B46H,09B77H,09BA8H,09BD9H ; 12.0- 12.7°
DW      09C0AH,09C3BH,09C6CH,09C9DH,09CCEH,09CFFH,09D30H,09D61H ; 12.7- 13.4°
DW      09D92H,09DC3H,09DF4H,09E25H,09E56H,09E86H,09EB7H,09EE8H ; 13.4- 14.1°
DW      09F19H,09F49H,09F7AH,09FABH,09FDCH,0A00CH,0A03DH,0A06EH ; 14.1- 14.8°
DW      0A09EH,0A0CFH,0A0FFH,0A130H,0A160H,0A191H,0A1C1H,0A1F2H ; 14.8- 15.5°
DW      0A222H,0A253H,0A283H,0A2B4H,0A2E4H,0A314H,0A345H,0A375H ; 15.5- 16.2°
DW      0A3A5H,0A3D6H,0A406H,0A436H,0A466H,0A496H,0A4C7H,0A4F7H ; 16.2- 16.9°
DW      0A527H,0A557H,0A587H,0A5B7H,0A5E7H,0A617H,0A647H,0A677H ; 16.9- 17.6°
DW      0A6A7H,0A6D7H,0A707H,0A736H,0A766H,0A796H,0A7C6H,0A7F6H ; 17.6- 18.3°
DW      0A825H,0A855H,0A885H,0A8B4H,0A8E4H,0A914H,0A943H,0A973H ; 18.3- 19.0°
DW      0A9A2H,0A9D2H,0AA01H,0AA31H,0AA60H,0AA90H,0AABFH,0AAEFH ; 19.0- 19.7°
DW      0AB1EH,0AB4DH,0AB7CH,0ABACH,0ABDBH,0AC0AH,0AC39H,0AC69H ; 19.7- 20.4°
DW      0AC98H,0ACC7H,0ACF6H,0AD25H,0AD54H,0AD83H,0ADB2H,0ADE1H ; 20.4- 21.1°
DW      0AE10H,0AE3FH,0AE6DH,0AE9CH,0AECBH,0AEFAH,0AF29H,0AF57H ; 21.1- 21.8°
DW      0AF86H,0AFB5H,0AFE3H,0B012H,0B040H,0B06FH,0B09DH,0B0CCH ; 21.8- 22.5°
DW      0B0FAH,0B129H,0B157H,0B186H,0B1B4H,0B1E2H,0B210H,0B23FH ; 22.5- 23.2°
DW      0B26DH,0B29BH,0B2C9H,0B2F7H,0B325H,0B354H,0B382H,0B3B0H ; 23.2- 23.9°
DW      0B3DEH,0B40BH,0B439H,0B467H,0B495H,0B4C3H,0B4F1H,0B51EH ; 23.9- 24.6°
DW      0B54CH,0B57AH,0B5A7H,0B5D5H,0B603H,0B630H,0B65EH,0B68BH ; 24.6- 25.3°
DW      0B6B9H,0B6E6H,0B714H,0B741H,0B76EH,0B79BH,0B7C9H,0B7F6H ; 25.3- 26.0°
DW      0B823H,0B850H,0B87DH,0B8AAH,0B8D8H,0B905H,0B932H,0B95FH ; 26.0- 26.7°
DW      0B98BH,0B9B8H,0B9E5H,0BA12H,0BA3FH,0BA6BH,0BA98H,0BAC5H ; 26.7- 27.4°
DW      0BAF1H,0BB1EH,0BB4BH,0BB77H,0BBA4H,0BBD0H,0BBFDH,0BC29H ; 27.4- 28.1°
```

```
DW      0BC55H,0BC82H,0BCAEH,0BCDAH,0BD06H,0BD32H,0BD5FH,0BD8BH ; 28.1- 28.8°
DW      0BDB7H,0BDE3H,0BE0FH,0BE3BH,0BE67H,0BE92H,0BEBEH,0BEEAH ; 28.8- 29.5°
DW      0BF16H,0BF42H,0BF6DH,0BF99H,0BFC4H,0BFF0H,0C01CH,0C047H ; 29.5- 30.2°
DW      0C072H,0C09EH,0C0C9H,0C0F5H,0C120H,0C14BH,0C176H,0C1A1H ; 30.2- 30.9°
DW      0C1CDH,0C1F8H,0C223H,0C24EH,0C279H,0C2A4H,0C2CFH,0C2F9H ; 30.9- 31.6°
DW      0C324H,0C34FH,0C37AH,0C3A4H,0C3CFH,0C3FAH,0C424H,0C44FH ; 31.6- 32.3°
DW      0C479H,0C4A4H,0C4CEH,0C4F8H,0C523H,0C54DH,0C577H,0C5A2H ; 32.3- 33.0°
DW      0C5CCH,0C5F6H,0C620H,0C64AH,0C674H,0C69EH,0C6C8H,0C6F2H ; 33.0- 33.8°
DW      0C71BH,0C745H,0C76FH,0C799H,0C7C2H,0C7ECH,0C815H,0C83FH ; 33.8- 34.5°
DW      0C868H,0C892H,0C8BBH,0C8E4H,0C90EH,0C937H,0C960H,0C989H ; 34.5- 35.2°
DW      0C9B3H,0C9DCH,0CA05H,0CA2EH,0CA57H,0CA7FH,0CAA8H,0CAD1H ; 35.2- 35.9°
DW      0CAFAH,0CB23H,0CB4BH,0CB74H,0CB9CH,0CBC5H,0CBEDH,0CC16H ; 35.9- 36.6°
DW      0CC3EH,0CC67H,0CC8FH,0CCB7H,0CCDFH,0CD08H,0CD30H,0CD58H ; 36.6- 37.3°
DW      0CD80H,0CDA8H,0CDD0H,0CDF8H,0CE1FH,0CE47H,0CE6FH,0CE97H ; 37.3- 38.0°
DW      0CEBEH,0CEE6H,0CF0DH,0CF35H,0CF5CH,0CF84H,0CFABH,0CFD3H ; 38.0- 38.7°
DW      0CFFAH,0D021H,0D048H,0D06FH,0D096H,0D0BDH,0D0E4H,0D10BH ; 38.7- 39.4°
DW      0D132H,0D159H,0D180H,0D1A7H,0D1CDH,0D1F4H,0D21AH,0D241H ; 39.4- 40.1°
DW      0D267H,0D28EH,0D2B4H,0D2DBH,0D301H,0D327H,0D34DH,0D373H ; 40.1- 40.8°
DW      0D39AH,0D3C0H,0D3E6H,0D40BH,0D431H,0D457H,0D47DH,0D4A3H ; 40.8- 41.5°
DW      0D4C8H,0D4EEH,0D514H,0D539H,0D55FH,0D584H,0D5A9H,0D5CFH ; 41.5- 42.2°
DW      0D5F4H,0D619H,0D63EH,0D663H,0D689H,0D6AEH,0D6D2H,0D6F7H ; 42.2- 42.9°
DW      0D71CH,0D741H,0D766H,0D78AH,0D7AFH,0D7D4H,0D7F8H,0D81DH ; 42.9- 43.6°
DW      0D841H,0D866H,0D88AH,0D8AEH,0D8D2H,0D8F7H,0D91BH,0D93FH ; 43.6- 44.3°
DW      0D963H,0D987H,0D9ABH,0D9CEH,0D9F2H,0DA16H,0DA3AH,0DA5DH ; 44.3- 45.0°
DW      0DA81H,0DAA4H,0DAC8H,0DAEBH,0DB0EH,0DB32H,0DB55H,0DB78H ; 45.0- 45.7°
DW      0DB9BH,0DBBEH,0DBE1H,0DC04H,0DC27H,0DC4AH,0DC6DH,0DC90H ; 45.7- 46.4°
DW      0DCB2H,0DCD5H,0DCF8H,0DD1AH,0DD3DH,0DD5FH,0DD81H,0DDA4H ; 46.4- 47.1°
DW      0DDC6H,0DDE8H,0DE0AH,0DE2CH,0DE4EH,0DE70H,0DE92H,0DEB4H ; 47.1- 47.8°
DW      0DED6H,0DEF7H,0DF19H,0DF3BH,0DF5CH,0DF7EH,0DF9FH,0DFC1H ; 47.8- 48.5°
DW      0DFE2H,0E003H,0E024H,0E046H,0E067H,0E088H,0E0A9H,0E0CAH ; 48.5- 49.2°
DW      0E0EAH,0E10BH,0E12CH,0E14DH,0E16DH,0E18EH,0E1AEH,0E1CFH ; 49.2- 49.9°
DW      0E1EFH,0E210H,0E230H,0E250H,0E270H,0E290H,0E2B0H,0E2D0H ; 49.9- 50.6°
DW      0E2F0H,0E310H,0E330H,0E350H,0E36FH,0E38FH,0E3AEH,0E3CEH ; 50.6- 51.3°
DW      0E3EDH,0E40DH,0E42CH,0E44BH,0E46BH,0E48AH,0E4A9H,0E4C8H ; 51.3- 52.0°
DW      0E4E7H,0E506H,0E524H,0E543H,0E562H,0E581H,0E59FH,0E5BEH ; 52.0- 52.7°
DW      0E5DCH,0E5FBH,0E619H,0E637H,0E655H,0E674H,0E692H,0E6B0H ; 52.7- 53.4°
DW      0E6CEH,0E6ECH,0E709H,0E727H,0E745H,0E763H,0E780H,0E79EH ; 53.4- 54.1°
DW      0E7BBH,0E7D9H,0E7F6H,0E813H,0E831H,0E84EH,0E86BH,0E888H ; 54.1- 54.8°
DW      0E8A5H,0E8C2H,0E8DFH,0E8FBH,0E918H,0E935H,0E951H,0E96EH ; 54.8- 55.5°
DW      0E98AH,0E9A7H,0E9C3H,0E9DFH,0E9FCH,0EA18H,0EA34H,0EA50H ; 55.5- 56.3°
DW      0EA6CH,0EA88H,0EAA3H,0EABFH,0EADBH,0EAF7H,0EB12H,0EB2EH ; 56.3- 57.0°
DW      0EB49H,0EB64H,0EB80H,0EB9BH,0EBB6H,0EBD1H,0EBECH,0EC07H ; 57.0- 57.7°
DW      0EC22H,0EC3DH,0EC58H,0EC73H,0EC8DH,0ECA8H,0ECC2H,0ECDDH ; 57.7- 58.4°
DW      0ECF7H,0ED12H,0ED2CH,0ED46H,0ED60H,0ED7AH,0ED94H,0EDAEH ; 58.4- 59.1°
DW      0EDC8H,0EDE2H,0EDFCH,0EE15H,0EE2FH,0EE49H,0EE62H,0EE7BH ; 59.1- 59.8°
DW      0EE95H,0EEAEH,0EEC7H,0EEE0H,0EEFAH,0EF13H,0EF2BH,0EF44H ; 59.8- 60.5°
DW      0EF5DH,0EF76H,0EF8FH,0EFA7H,0EFC0H,0EFD8H,0EFF1H,0F009H ; 60.5- 61.2°
DW      0F021H,0F039H,0F052H,0F06AH,0F082H,0F09AH,0F0B1H,0F0C9H ; 61.2- 61.9°
DW      0F0E1H,0F0F9H,0F110H,0F128H,0F13FH,0F157H,0F16EH,0F185H ; 61.9- 62.6°
DW      0F19CH,0F1B3H,0F1CAH,0F1E1H,0F1F8H,0F20FH,0F226H,0F23DH ; 62.6- 63.3°
DW      0F253H,0F26AH,0F280H,0F297H,0F2ADH,0F2C3H,0F2DAH,0F2F0H ; 63.3- 64.0°
DW      0F306H,0F31CH,0F332H,0F348H,0F35DH,0F373H,0F389H,0F39EH ; 64.0- 64.7°
DW      0F3B4H,0F3C9H,0F3DFH,0F3F4H,0F409H,0F41FH,0F434H,0F449H ; 64.7- 65.4°
DW      0F45EH,0F473H,0F487H,0F49CH,0F4B1H,0F4C5H,0F4DAH,0F4EFH ; 65.4- 66.1°
DW      0F503H,0F517H,0F52CH,0F540H,0F554H,0F568H,0F57CH,0F590H ; 66.1- 66.8°
DW      0F5A4H,0F5B7H,0F5CBH,0F5DFH,0F5F2H,0F606H,0F619H,0F62CH ; 66.8- 67.5°
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DW      0F640H,0F653H,0F666H,0F679H,0F68CH,0F69FH,0F6B2H,0F6C5H ; 67.5- 68.2°
DW      0F6D7H,0F6EAH,0F6FDH,0F70FH,0F721H,0F734H,0F746H,0F758H ; 68.2- 68.9°
DW      0F76AH,0F77CH,0F78EH,0F7A0H,0F7B2H,0F7C4H,0F7D6H,0F7E7H ; 68.9- 69.6°
DW      0F7F9H,0F80AH,0F81CH,0F82DH,0F83EH,0F84FH,0F861H,0F872H ; 69.6- 70.3°
DW      0F883H,0F893H,0F8A4H,0F8B5H,0F8C6H,0F8D6H,0F8E7H,0F8F7H ; 70.3- 71.0°
DW      0F908H,0F918H,0F928H,0F938H,0F949H,0F959H,0F969H,0F978H ; 71.0- 71.7°
DW      0F988H,0F998H,0F9A8H,0F9B7H,0F9C7H,0F9D6H,0F9E5H,0F9F5H ; 71.7- 72.4°
DW      0FA04H,0FA13H,0FA22H,0FA31H,0FA40H,0FA4FH,0FA5EH,0FA6CH ; 72.4- 73.1°
DW      0FA7BH,0FA8AH,0FA98H,0FAA7H,0FAB5H,0FAC3H,0FAD1H,0FADFH ; 73.1- 73.8°
DW      0FAEDH,0FAFBH,0FB09H,0FB17H,0FB25H,0FB32H,0FB40H,0FB4EH ; 73.8- 74.5°
DW      0FB5BH,0FB68H,0FB76H,0FB83H,0FB90H,0FB9DH,0FBAAH,0FBB7H ; 74.5- 75.2°
DW      0FBC4H,0FBD1H,0FBDDH,0FBEAH,0FBF7H,0FC03H,0FC0FH,0FC1CH ; 75.2- 75.9°
DW      0FC28H,0FC34H,0FC40H,0FC4CH,0FC58H,0FC64H,0FC70H,0FC7CH ; 75.9- 76.6°
DW      0FC87H,0FC93H,0FC9EH,0FCAAH,0FCB5H,0FCC0H,0FCCCH,0FCD7H ; 76.6- 77.3°
DW      0FCE2H,0FCEDH,0FCF8H,0FD03H,0FD0DH,0FD18H,0FD23H,0FD2DH ; 77.3- 78.0°
DW      0FD38H,0FD42H,0FD4CH,0FD56H,0FD61H,0FD6BH,0FD75H,0FD7FH ; 78.0- 78.8°
DW      0FD88H,0FD92H,0FD9CH,0FDA5H,0FDAFH,0FDB8H,0FDC2H,0FDCBH ; 78.8- 79.5°
DW      0FDD4H,0FDDEH,0FDE7H,0FDF0H,0FDF9H,0FE01H,0FE0AH,0FE13H ; 79.5- 80.2°
DW      0FE1CH,0FE24H,0FE2DH,0FE35H,0FE3DH,0FE46H,0FE4EH,0FE56H ; 80.2- 80.9°
DW      0FE5EH,0FE66H,0FE6EH,0FE76H,0FE7DH,0FE85H,0FE8CH,0FE94H ; 80.9- 81.6°
DW      0FE9BH,0FEA3H,0FEAAH,0FEB1H,0FEB8H,0FEBFH,0FEC6H,0FECDH ; 81.6- 82.3°
DW      0FED4H,0FEDBH,0FEE1H,0FEE8H,0FEEEH,0FEF5H,0FEFBH,0FF01H ; 82.3- 83.0°
DW      0FF08H,0FF0EH,0FF14H,0FF1AH,0FF20H,0FF25H,0FF2BH,0FF31H ; 83.0- 83.7°
DW      0FF36H,0FF3CH,0FF41H,0FF47H,0FF4CH,0FF51H,0FF56H,0FF5BH ; 83.7- 84.4°
DW      0FF60H,0FF65H,0FF6AH,0FF6FH,0FF73H,0FF78H,0FF7CH,0FF81H ; 84.4- 85.1°
DW      0FF85H,0FF89H,0FF8EH,0FF92H,0FF96H,0FF9AH,0FF9EH,0FFA1H ; 85.1- 85.8°
DW      0FFA5H,0FFA9H,0FFACH,0FFB0H,0FFB3H,0FFB7H,0FFBAH,0FFBDH ; 85.8- 86.5°
DW      0FFC0H,0FFC3H,0FFC6H,0FFC9H,0FFCCH,0FFCFH,0FFD1H,0FFD4H ; 86.5- 87.2°
DW      0FFD7H,0FFD9H,0FFDBH,0FFDEH,0FFE0H,0FFE2H,0FFE4H,0FFE6H ; 87.2- 87.9°
DW      0FFE8H,0FFEAH,0FFEBH,0FFEDH,0FFEFH,0FFF0H,0FFF2H,0FFF3H ; 87.9- 88.6°
DW      0FFF4H,0FFF5H,0FFF6H,0FFF7H,0FFF8H,0FFF9H,0FFFAH,0FFFBH ; 88.6- 89.3°
DW      0FFFCH,0FFFCH,0FFFDH,0FFFDH,0FFFDH,0FFFEH,0FFFEH,0FFFEH ; 89.3- 90.0°
DW      0FFFEH,0FFFEH,0FFFEH,0FFFEH,0FFFDH,0FFFDH,0FFFDH,0FFFCH ; 90.0- 90.7°
DW      0FFFCH,0FFFBH,0FFFAH,0FFF9H,0FFF8H,0FFF7H,0FFF6H,0FFF5H ; 90.7- 91.4°
DW      0FFF4H,0FFF3H,0FFF2H,0FFF0H,0FFEFH,0FFEDH,0FFEBH,0FFEAH ; 91.4- 92.1°
DW      0FFE8H,0FFE6H,0FFE4H,0FFE2H,0FFE0H,0FFDEH,0FFDBH,0FFD9H ; 92.1- 92.8°
DW      0FFD7H,0FFD4H,0FFD1H,0FFCFH,0FFCCH,0FFC9H,0FFC6H,0FFC3H ; 92.8- 93.5°
DW      0FFC0H,0FFBDH,0FFBAH,0FFB7H,0FFB3H,0FFB0H,0FFACH,0FFA9H ; 93.5- 94.2°
DW      0FFA5H,0FFA1H,0FF9EH,0FF9AH,0FF96H,0FF92H,0FF8EH,0FF89H ; 94.2- 94.9°
DW      0FF85H,0FF81H,0FF7CH,0FF78H,0FF73H,0FF6FH,0FF6AH,0FF65H ; 94.9- 95.6°
DW      0FF60H,0FF5BH,0FF56H,0FF51H,0FF4CH,0FF47H,0FF41H,0FF3CH ; 95.6- 96.3°
DW      0FF36H,0FF31H,0FF2BH,0FF25H,0FF20H,0FF1AH,0FF14H,0FF0EH ; 96.3- 97.0°
DW      0FF08H,0FF01H,0FEFBH,0FEF5H,0FEEEH,0FEE8H,0FEE1H,0FEDBH ; 97.0- 97.7°
DW      0FED4H,0FECDH,0FEC6H,0FEBFH,0FEB8H,0FEB1H,0FEAAH,0FEA3H ; 97.7- 98.4°
DW      0FE9BH,0FE94H,0FE8CH,0FE85H,0FE7DH,0FE76H,0FE6EH,0FE66H ; 98.4- 99.1°
DW      0FE5EH,0FE56H,0FE4EH,0FE46H,0FE3DH,0FE35H,0FE2DH,0FE24H ; 99.1- 99.8°
DW      0FE1CH,0FE13H,0FE0AH,0FE01H,0FDF9H,0FDF0H,0FDE7H,0FDDEH ; 99.8-100.5°
DW      0FDD4H,0FDCBH,0FDC2H,0FDB8H,0FDAFH,0FDA5H,0FD9CH,0FD92H ;100.5-101.3°
DW      0FD88H,0FD7FH,0FD75H,0FD6BH,0FD61H,0FD56H,0FD4CH,0FD42H ;101.3-102.0°
DW      0FD38H,0FD2DH,0FD23H,0FD18H,0FD0DH,0FD03H,0FCF8H,0FCEDH ;102.0-102.7°
DW      0FCE2H,0FCD7H,0FCCCH,0FCC0H,0FCB5H,0FCAAH,0FC9EH,0FC93H ;102.7-103.4°
DW      0FC87H,0FC7CH,0FC70H,0FC64H,0FC58H,0FC4CH,0FC40H,0FC34H ;103.4-104.1°
DW      0FC28H,0FC1CH,0FC0FH,0FC03H,0FBF7H,0FBEAH,0FBDDH,0FBD1H ;104.1-104.8°
DW      0FBC4H,0FBB7H,0FBAAH,0FB9DH,0FB90H,0FB83H,0FB76H,0FB68H ;104.8-105.5°
DW      0FB5BH,0FB4EH,0FB40H,0FB32H,0FB25H,0FB17H,0FB09H,0FAFBH ;105.5-106.2°
DW      0FAEDH,0FADFH,0FAD1H,0FAC3H,0FAB5H,0FAA7H,0FA98H,0FA8AH ;106.2-106.9°
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DW      0FA7BH,0FA6CH,0FA5EH,0FA4FH,0FA40H,0FA31H,0FA22H,0FA13H ;106.9-107.6°
DW      0FA04H,0F9F5H,0F9E5H,0F9D6H,0F9C7H,0F9B7H,0F9A8H,0F998H ;107.6-108.3°
DW      0F988H,0F978H,0F969H,0F959H,0F949H,0F938H,0F928H,0F918H ;108.3-109.0°
DW      0F908H,0F8F7H,0F8E7H,0F8D6H,0F8C6H,0F8B5H,0F8A4H,0F893H ;109.0-109.7°
DW      0F883H,0F872H,0F861H,0F84FH,0F83EH,0F82DH,0F81CH,0F80AH ;109.7-110.4°
DW      0F7F9H,0F7E7H,0F7D6H,0F7C4H,0F7B2H,0F7A0H,0F78EH,0F77CH ;110.4-111.1°
DW      0F76AH,0F758H,0F746H,0F734H,0F721H,0F70FH,0F6FDH,0F6EAH ;111.1-111.8°
DW      0F6D7H,0F6C5H,0F6B2H,0F69FH,0F68CH,0F679H,0F666H,0F653H ;111.8-112.5°
DW      0F640H,0F62CH,0F619H,0F606H,0F5F2H,0F5DFH,0F5CBH,0F5B7H ;112.5-113.2°
DW      0F5A4H,0F590H,0F57CH,0F568H,0F554H,0F540H,0F52CH,0F517H ;113.2-113.9°
DW      0F503H,0F4EFH,0F4DAH,0F4C5H,0F4B1H,0F49CH,0F487H,0F473H ;113.9-114.6°
DW      0F45EH,0F449H,0F434H,0F41FH,0F409H,0F3F4H,0F3DFH,0F3C9H ;114.6-115.3°
DW      0F3B4H,0F39EH,0F389H,0F373H,0F35DH,0F348H,0F332H,0F31CH ;115.3-116.0°
DW      0F306H,0F2F0H,0F2DAH,0F2C3H,0F2ADH,0F297H,0F280H,0F26AH ;116.0-116.7°
DW      0F253H,0F23DH,0F226H,0F20FH,0F1F8H,0F1E1H,0F1CAH,0F1B3H ;116.7-117.4°
DW      0F19CH,0F185H,0F16EH,0F157H,0F13FH,0F128H,0F110H,0F0F9H ;117.4-118.1°
DW      0F0E1H,0F0C9H,0F0B1H,0F09AH,0F082H,0F06AH,0F052H,0F039H ;118.1-118.8°
DW      0F021H,0F009H,0EFF1H,0EFD8H,0EFC0H,0EFA7H,0EF8FH,0EF76H ;118.8-119.5°
DW      0EF5DH,0EF44H,0EF2BH,0EF13H,0EEFAH,0EEE0H,0EEC7H,0EEAEH ;119.5-120.2°
DW      0EE95H,0EE7BH,0EE62H,0EE49H,0EE2FH,0EE15H,0EDFCH,0EDE2H ;120.2-120.9°
DW      0EDC8H,0EDAEH,0ED94H,0ED7AH,0ED60H,0ED46H,0ED2CH,0ED12H ;120.9-121.6°
DW      0ECF7H,0ECDDH,0ECC2H,0ECA8H,0EC8DH,0EC73H,0EC58H,0EC3DH ;121.6-122.3°
DW      0EC22H,0EC07H,0EBECH,0EBD1H,0EBB6H,0EB9BH,0EB80H,0EB64H ;122.3-123.0°
DW      0EB49H,0EB2EH,0EB12H,0EAF7H,0EADBH,0EABFH,0EAA3H,0EA88H ;123.0-123.8°
DW      0EA6CH,0EA50H,0EA34H,0EA18H,0E9FCH,0E9DFH,0E9C3H,0E9A7H ;123.8-124.5°
DW      0E98AH,0E96EH,0E951H,0E935H,0E918H,0E8FBH,0E8DFH,0E8C2H ;124.5-125.2°
DW      0E8A5H,0E888H,0E86BH,0E84EH,0E831H,0E813H,0E7F6H,0E7D9H ;125.2-125.9°
DW      0E7BBH,0E79EH,0E780H,0E763H,0E745H,0E727H,0E709H,0E6ECH ;125.9-126.6°
DW      0E6CEH,0E6B0H,0E692H,0E674H,0E655H,0E637H,0E619H,0E5FBH ;126.6-127.3°
DW      0E5DCH,0E5BEH,0E59FH,0E581H,0E562H,0E543H,0E524H,0E506H ;127.3-128.0°
DW      0E4E7H,0E4C8H,0E4A9H,0E48AH,0E46BH,0E44BH,0E42CH,0E40DH ;128.0-128.7°
DW      0E3EDH,0E3CEH,0E3AEH,0E38FH,0E36FH,0E350H,0E330H,0E310H ;128.7-129.4°
DW      0E2F0H,0E2D0H,0E2B0H,0E290H,0E270H,0E250H,0E230H,0E210H ;129.4-130.1°
DW      0E1EFH,0E1CFH,0E1AEH,0E18EH,0E16DH,0E14DH,0E12CH,0E10BH ;130.1-130.8°
DW      0E0EAH,0E0CAH,0E0A9H,0E088H,0E067H,0E046H,0E024H,0E003H ;130.8-131.5°
DW      0DFE2H,0DFC1H,0DF9FH,0DF7EH,0DF5CH,0DF3BH,0DF19H,0DEF7H ;131.5-132.2°
DW      0DED6H,0DEB4H,0DE92H,0DE70H,0DE4EH,0DE2CH,0DE0AH,0DDE8H ;132.2-132.9°
DW      0DDC6H,0DDA4H,0DD81H,0DD5FH,0DD3DH,0DD1AH,0DCF8H,0DCD5H ;132.9-133.6°
DW      0DCB2H,0DC90H,0DC6DH,0DC4AH,0DC27H,0DC04H,0DBE1H,0DBBEH ;133.6-134.3°
DW      0DB9BH,0DB78H,0DB55H,0DB32H,0DB0EH,0DAEBH,0DAC8H,0DAA4H ;134.3-135.0°
DW      0DA81H,0DA5DH,0DA3AH,0DA16H,0D9F2H,0D9CEH,0D9ABH,0D987H ;135.0-135.7°
DW      0D963H,0D93FH,0D91BH,0D8F7H,0D8D2H,0D8AEH,0D88AH,0D866H ;135.7-136.4°
DW      0D841H,0D81DH,0D7F8H,0D7D4H,0D7AFH,0D78AH,0D766H,0D741H ;136.4-137.1°
DW      0D71CH,0D6F7H,0D6D2H,0D6AEH,0D689H,0D663H,0D63EH,0D619H ;137.1-137.8°
DW      0D5F4H,0D5CFH,0D5A9H,0D584H,0D55FH,0D539H,0D514H,0D4EEH ;137.8-138.5°
DW      0D4C8H,0D4A3H,0D47DH,0D457H,0D431H,0D40BH,0D3E6H,0D3C0H ;138.5-139.2°
DW      0D39AH,0D373H,0D34DH,0D327H,0D301H,0D2DBH,0D2B4H,0D28EH ;139.2-139.9°
DW      0D267H,0D241H,0D21AH,0D1F4H,0D1CDH,0D1A7H,0D180H,0D159H ;139.9-140.6°
DW      0D132H,0D10BH,0D0E4H,0D0BDH,0D096H,0D06FH,0D048H,0D021H ;140.6-141.3°
DW      0CFFAH,0CFD3H,0CFABH,0CF84H,0CF5CH,0CF35H,0CF0DH,0CEE6H ;141.3-142.0°
DW      0CEBEH,0CE97H,0CE6FH,0CE47H,0CE1FH,0CDF8H,0CDD0H,0CDA8H ;142.0-142.7°
DW      0CD80H,0CD58H,0CD30H,0CD08H,0CCDFH,0CCB7H,0CC8FH,0CC67H ;142.7-143.4°
DW      0CC3EH,0CC16H,0CBEDH,0CBC5H,0CB9CH,0CB74H,0CB4BH,0CB23H ;143.4-144.1°
DW      0CAFAH,0CAD1H,0CAA8H,0CA7FH,0CA57H,0CA2EH,0CA05H,0C9DCH ;144.1-144.8°
DW      0C9B3H,0C989H,0C960H,0C937H,0C90EH,0C8E4H,0C8BBH,0C892H ;144.8-145.5°
DW      0C868H,0C83FH,0C815H,0C7ECH,0C7C2H,0C799H,0C76FH,0C745H ;145.5-146.3°
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DW      0C71BH,0C6F2H,0C6C8H,0C69EH,0C674H,0C64AH,0C620H,0C5F6H ;146.3-147.0°
DW      0C5CCH,0C5A2H,0C577H,0C54DH,0C523H,0C4F8H,0C4CEH,0C4A4H ;147.0-147.7°
DW      0C479H,0C44FH,0C424H,0C3FAH,0C3CFH,0C3A4H,0C37AH,0C34FH ;147.7-148.4°
DW      0C324H,0C2F9H,0C2CFH,0C2A4H,0C279H,0C24EH,0C223H,0C1F8H ;148.4-149.1°
DW      0C1CDH,0C1A1H,0C176H,0C14BH,0C120H,0C0F5H,0C0C9H,0C09EH ;149.1-149.8°
DW      0C072H,0C047H,0C01CH,0BFF0H,0BFC4H,0BF99H,0BF6DH,0BF42H ;149.8-150.5°
DW      0BF16H,0BEEAH,0BEBEH,0BE92H,0BE67H,0BE3BH,0BE0FH,0BDE3H ;150.5-151.2°
DW      0BDB7H,0BD8BH,0BD5FH,0BD32H,0BD06H,0BCDAH,0BCAEH,0BC82H ;151.2-151.9°
DW      0BC55H,0BC29H,0BBFDH,0BBD0H,0BBA4H,0BB77H,0BB4BH,0BB1EH ;151.9-152.6°
DW      0BAF1H,0BAC5H,0BA98H,0BA6BH,0BA3FH,0BA12H,0B9E5H,0B9B8H ;152.6-153.3°
DW      0B98BH,0B95FH,0B932H,0B905H,0B8D8H,0B8AAH,0B87DH,0B850H ;153.3-154.0°
DW      0B823H,0B7F6H,0B7C9H,0B79BH,0B76EH,0B741H,0B714H,0B6E6H ;154.0-154.7°
DW      0B6B9H,0B68BH,0B65EH,0B630H,0B603H,0B5D5H,0B5A7H,0B57AH ;154.7-155.4°
DW      0B54CH,0B51EH,0B4F1H,0B4C3H,0B495H,0B467H,0B439H,0B40BH ;155.4-156.1°
DW      0B3DEH,0B3B0H,0B382H,0B354H,0B325H,0B2F7H,0B2C9H,0B29BH ;156.1-156.8°
DW      0B26DH,0B23FH,0B210H,0B1E2H,0B1B4H,0B186H,0B157H,0B129H ;156.8-157.5°
DW      0B0FAH,0B0CCH,0B09DH,0B06FH,0B040H,0B012H,0AFE3H,0AFB5H ;157.5-158.2°
DW      0AF86H,0AF57H,0AF29H,0AEFAH,0AECBH,0AE9CH,0AE6DH,0AE3FH ;158.2-158.9°
DW      0AE10H,0ADE1H,0ADB2H,0AD83H,0AD54H,0AD25H,0ACF6H,0ACC7H ;158.9-159.6°
DW      0AC98H,0AC69H,0AC39H,0AC0AH,0ABDBH,0ABACH,0AB7CH,0AB4DH ;159.6-160.3°
DW      0AB1EH,0AAEFH,0AABFH,0AA90H,0AA60H,0AA31H,0AA01H,0A9D2H ;160.3-161.0°
DW      0A9A2H,0A973H,0A943H,0A914H,0A8E4H,0A8B4H,0A885H,0A855H ;161.0-161.7°
DW      0A825H,0A7F6H,0A7C6H,0A796H,0A766H,0A736H,0A707H,0A6D7H ;161.7-162.4°
DW      0A6A7H,0A677H,0A647H,0A617H,0A5E7H,0A5B7H,0A587H,0A557H ;162.4-163.1°
DW      0A527H,0A4F7H,0A4C7H,0A496H,0A466H,0A436H,0A406H,0A3D6H ;163.1-163.8°
DW      0A3A5H,0A375H,0A345H,0A314H,0A2E4H,0A2B4H,0A283H,0A253H ;163.8-164.5°
DW      0A222H,0A1F2H,0A1C1H,0A191H,0A160H,0A130H,0A0FFH,0A0CFH ;164.5-165.2°
DW      0A09EH,0A06EH,0A03DH,0A00CH,09FDCH,09FABH,09F7AH,09F49H ;165.2-165.9°
DW      09F19H,09EE8H,09EB7H,09E86H,09E56H,09E25H,09DF4H,09DC3H ;165.9-166.6°
DW      09D92H,09D61H,09D30H,09CFFH,09CCEH,09C9DH,09C6CH,09C3BH ;166.6-167.3°
DW      09C0AH,09BD9H,09BA8H,09B77H,09B46H,09B15H,09AE4H,09AB3H ;167.3-168.0°
DW      09A81H,09A50H,09A1FH,099EEH,099BDH,0998BH,0995AH,09929H ;168.0-168.8°
DW      098F8H,098C6H,09895H,09864H,09832H,09801H,097CFH,0979EH ;168.8-169.5°
DW      0976DH,0973BH,0970AH,096D8H,096A7H,09675H,09644H,09612H ;169.5-170.2°
DW      095E1H,095AFH,0957EH,0954CH,0951BH,094E9H,094B8H,09486H ;170.2-170.9°
DW      09454H,09423H,093F1H,093BFH,0938EH,0935CH,0932AH,092F9H ;170.9-171.6°
DW      092C7H,09295H,09263H,09232H,09200H,091CEH,0919CH,0916BH ;171.6-172.3°
DW      09139H,09107H,090D5H,090A3H,09071H,09040H,0900EH,08FDCH ;172.3-173.0°
DW      08FAAH,08F78H,08F46H,08F14H,08EE2H,08EB0H,08E7FH,08E4DH ;173.0-173.7°
DW      08E1BH,08DE9H,08DB7H,08D85H,08D53H,08D21H,08CEFH,08CBDH ;173.7-174.4°
DW      08C8BH,08C59H,08C27H,08BF5H,08BC3H,08B91H,08B5EH,08B2CH ;174.4-175.1°
DW      08AFAH,08AC8H,08A96H,08A64H,08A32H,08A00H,089CEH,0899CH ;175.1-175.8°
DW      08969H,08937H,08905H,088D3H,088A1H,0886FH,0883DH,0880AH ;175.8-176.5°
DW      087D8H,087A6H,08774H,08742H,08710H,086DDH,086ABH,08679H ;176.5-177.2°
DW      08647H,08615H,085E2H,085B0H,0857EH,0854CH,0851AH,084E7H ;177.2-177.9°
DW      084B5H,08483H,08451H,0841EH,083ECH,083BAH,08388H,08355H ;177.9-178.6°
DW      08323H,082F1H,082BFH,0828CH,0825AH,08228H,081F6H,081C3H ;178.6-179.3°
DW      08191H,0815FH,0812DH,080FAH,080C8H,08096H,08064H,08031H ;179.3-180.0°
DW      07FFFH,07FCDH,07F9AH,07F68H,07F36H,07F04H,07ED1H,07E9FH ;180.0-180.7°
DW      07E6DH,07E3BH,07E08H,07DD6H,07DA4H,07D72H,07D3FH,07D0DH ;180.7-181.4°
DW      07CDBH,07CA9H,07C76H,07C44H,07C12H,07BE0H,07BADH,07B7BH ;181.4-182.1°
DW      07B49H,07B17H,07AE4H,07AB2H,07A80H,07A4EH,07A1CH,079E9H ;182.1-182.8°
DW      079B7H,07985H,07953H,07921H,078EEH,078BCH,0788AH,07858H ;182.8-183.5°
DW      07826H,077F4H,077C1H,0778FH,0775DH,0772BH,076F9H,076C7H ;183.5-184.2°
DW      07695H,07662H,07630H,075FEH,075CCH,0759AH,07568H,07536H ;184.2-184.9°
DW      07504H,074D2H,074A0H,0746DH,0743BH,07409H,073D7H,073A5H ;184.9-185.6°
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DW      07373H,07341H,0730FH,072DDH,072ABH,07279H,07247H,07215H ;185.6-186.3°
DW      071E3H,071B1H,0717FH,0714EH,0711CH,070EAH,070B8H,07086H ;186.3-187.0°
DW      07054H,07022H,06FF0H,06FBEH,06F8DH,06F5BH,06F29H,06EF7H ;187.0-187.7°
DW      06EC5H,06E93H,06E62H,06E30H,06DFEH,06DCCH,06D9BH,06D69H ;187.7-188.4°
DW      06D37H,06D05H,06CD4H,06CA2H,06C70H,06C3FH,06C0DH,06BDBH ;188.4-189.1°
DW      06BAAH,06B78H,06B46H,06B15H,06AE3H,06AB2H,06A80H,06A4FH ;189.1-189.8°
DW      06A1DH,069ECH,069BAH,06989H,06957H,06926H,068F4H,068C3H ;189.8-190.5°
DW      06891H,06860H,0682FH,067FDH,067CCH,0679AH,06769H,06738H ;190.5-191.3°
DW      06706H,066D5H,066A4H,06673H,06641H,06610H,065DFH,065AEH ;191.3-192.0°
DW      0657DH,0654BH,0651AH,064E9H,064B8H,06487H,06456H,06425H ;192.0-192.7°
DW      063F4H,063C3H,06392H,06361H,06330H,062FFH,062CEH,0629DH ;192.7-193.4°
DW      0626CH,0623BH,0620AH,061D9H,061A8H,06178H,06147H,06116H ;193.4-194.1°
DW      060E5H,060B5H,06084H,06053H,06022H,05FF2H,05FC1H,05F90H ;194.1-194.8°
DW      05F60H,05F2FH,05EFFH,05ECEH,05E9EH,05E6DH,05E3DH,05E0CH ;194.8-195.5°
DW      05DDCH,05DABH,05D7BH,05D4AH,05D1AH,05CEAH,05CB9H,05C89H ;195.5-196.2°
DW      05C59H,05C28H,05BF8H,05BC8H,05B98H,05B68H,05B37H,05B07H ;196.2-196.9°
DW      05AD7H,05AA7H,05A77H,05A47H,05A17H,059E7H,059B7H,05987H ;196.9-197.6°
DW      05957H,05927H,058F7H,058C8H,05898H,05868H,05838H,05808H ;197.6-198.3°
DW      057D9H,057A9H,05779H,0574AH,0571AH,056EAH,056BBH,0568BH ;198.3-199.0°
DW      0565CH,0562CH,055FDH,055CDH,0559EH,0556EH,0553FH,0550FH ;199.0-199.7°
DW      054E0H,054B1H,05482H,05452H,05423H,053F4H,053C5H,05395H ;199.7-200.4°
DW      05366H,05337H,05308H,052D9H,052AAH,0527BH,0524CH,0521DH ;200.4-201.1°
DW      051EEH,051BFH,05191H,05162H,05133H,05104H,050D5H,050A7H ;201.1-201.8°
DW      05078H,05049H,0501BH,04FECH,04FBEH,04F8FH,04F61H,04F32H ;201.8-202.5°
DW      04F04H,04ED5H,04EA7H,04E78H,04E4AH,04E1CH,04DEEH,04DBFH ;202.5-203.2°
DW      04D91H,04D63H,04D35H,04D07H,04CD9H,04CAAH,04C7CH,04C4EH ;203.2-203.9°
DW      04C20H,04BF3H,04BC5H,04B97H,04B69H,04B3BH,04B0DH,04AE0H ;203.9-204.6°
DW      04AB2H,04A84H,04A57H,04A29H,049FBH,049CEH,049A0H,04973H ;204.6-205.3°
DW      04945H,04918H,048EAH,048BDH,04890H,04863H,04835H,04808H ;205.3-206.0°
DW      047DBH,047AEH,04781H,04754H,04726H,046F9H,046CCH,0469FH ;206.0-206.7°
DW      04673H,04646H,04619H,045ECH,045BFH,04593H,04566H,04539H ;206.7-207.4°
DW      0450DH,044E0H,044B3H,04487H,0445AH,0442EH,04401H,043D5H ;207.4-208.1°
DW      043A9H,0437CH,04350H,04324H,042F8H,042CCH,0429FH,04273H ;208.1-208.8°
DW      04247H,0421BH,041EFH,041C3H,04197H,0416CH,04140H,04114H ;208.8-209.5°
DW      040E8H,040BCH,04091H,04065H,0403AH,0400EH,03FE2H,03FB7H ;209.5-210.2°
DW      03F8CH,03F60H,03F35H,03F09H,03EDEH,03EB3H,03E88H,03E5DH ;210.2-210.9°
DW      03E31H,03E06H,03DDBH,03DB0H,03D85H,03D5AH,03D2FH,03D05H ;210.9-211.6°
DW      03CDAH,03CAFH,03C84H,03C5AH,03C2FH,03C04H,03BDAH,03BAFH ;211.6-212.3°
DW      03B85H,03B5AH,03B30H,03B06H,03ADBH,03AB1H,03A87H,03A5CH ;212.3-213.0°
DW      03A32H,03A08H,039DEH,039B4H,0398AH,03960H,03936H,0390CH ;213.0-213.8°
DW      038E3H,038B9H,0388FH,03865H,0383CH,03812H,037E9H,037BFH ;213.8-214.5°
DW      03796H,0376CH,03743H,0371AH,036F0H,036C7H,0369EH,03675H ;214.5-215.2°
DW      0364BH,03622H,035F9H,035D0H,035A7H,0357FH,03556H,0352DH ;215.2-215.9°
DW      03504H,034DBH,034B3H,0348AH,03462H,03439H,03411H,033E8H ;215.9-216.6°
DW      033C0H,03397H,0336FH,03347H,0331FH,032F6H,032CEH,032A6H ;216.6-217.3°
DW      0327EH,03256H,0322EH,03206H,031DFH,031B7H,0318FH,03167H ;217.3-218.0°
DW      03140H,03118H,030F1H,030C9H,030A2H,0307AH,03053H,0302BH ;218.0-218.7°
DW      03004H,02FDDH,02FB6H,02F8FH,02F68H,02F41H,02F1AH,02EF3H ;218.7-219.4°
DW      02ECCH,02EA5H,02E7EH,02E57H,02E31H,02E0AH,02DE4H,02DBDH ;219.4-220.1°
DW      02D97H,02D70H,02D4AH,02D23H,02CFDH,02CD7H,02CB1H,02C8BH ;220.1-220.8°
DW      02C64H,02C3EH,02C18H,02BF3H,02BCDH,02BA7H,02B81H,02B5BH ;220.8-221.5°
DW      02B36H,02B10H,02AEAH,02AC5H,02A9FH,02A7AH,02A55H,02A2FH ;221.5-222.2°
DW      02A0AH,029E5H,029C0H,0299BH,02975H,02950H,0292CH,02907H ;222.2-222.9°
DW      028E2H,028BDH,02898H,02874H,0284FH,0282AH,02806H,027E1H ;222.9-223.6°
DW      027BDH,02798H,02774H,02750H,0272CH,02707H,026E3H,026BFH ;223.6-224.3°
DW      0269BH,02677H,02653H,02630H,0260CH,025E8H,025C4H,025A1H ;224.3-225.0°
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DW      0257DH,0255AH,02536H,02513H,024F0H,024CCH,024A9H,02486H ;225.0-225.7°
DW      02463H,02440H,0241DH,023FAH,023D7H,023B4H,02391H,0236EH ;225.7-226.4°
DW      0234CH,02329H,02306H,022E4H,022C1H,0229FH,0227DH,0225AH ;226.4-227.1°
DW      02238H,02216H,021F4H,021D2H,021B0H,0218EH,0216CH,0214AH ;227.1-227.8°
DW      02128H,02107H,020E5H,020C3H,020A2H,02080H,0205FH,0203DH ;227.8-228.5°
DW      0201CH,01FFBH,01FDAH,01FB8H,01F97H,01F76H,01F55H,01F34H ;228.5-229.2°
DW      01F14H,01EF3H,01ED2H,01EB1H,01E91H,01E70H,01E50H,01E2FH ;229.2-229.9°
DW      01E0FH,01DEEH,01DCEH,01DAEH,01D8EH,01D6EH,01D4EH,01D2EH ;229.9-230.6°
DW      01D0EH,01CEEH,01CCEH,01CAEH,01C8FH,01C6FH,01C50H,01C30H ;230.6-231.3°
DW      01C11H,01BF1H,01BD2H,01BB3H,01B93H,01B74H,01B55H,01B36H ;231.3-232.0°
DW      01B17H,01AF8H,01ADAH,01ABBH,01A9CH,01A7DH,01A5FH,01A40H ;232.0-232.7°
DW      01A22H,01A03H,019E5H,019C7H,019A9H,0198AH,0196CH,0194EH ;232.7-233.4°
DW      01930H,01912H,018F5H,018D7H,018B9H,0189BH,0187EH,01860H ;233.4-234.1°
DW      01843H,01825H,01808H,017EBH,017CDH,017B0H,01793H,01776H ;234.1-234.8°
DW      01759H,0173CH,0171FH,01703H,016E6H,016C9H,016ADH,01690H ;234.8-235.5°
DW      01674H,01657H,0163BH,0161FH,01602H,015E6H,015CAH,015AEH ;235.5-236.3°
DW      01592H,01576H,0155BH,0153FH,01523H,01507H,014ECH,014D0H ;236.3-237.0°
DW      014B5H,0149AH,0147EH,01463H,01448H,0142DH,01412H,013F7H ;237.0-237.7°
DW      013DCH,013C1H,013A6H,0138BH,01371H,01356H,0133CH,01321H ;237.7-238.4°
DW      01307H,012ECH,012D2H,012B8H,0129EH,01284H,0126AH,01250H ;238.4-239.1°
DW      01236H,0121CH,01202H,011E9H,011CFH,011B5H,0119CH,01183H ;239.1-239.8°
DW      01169H,01150H,01137H,0111EH,01104H,010EBH,010D3H,010BAH ;239.8-240.5°
DW      010A1H,01088H,0106FH,01057H,0103EH,01026H,0100DH,00FF5H ;240.5-241.2°
DW      00FDDH,00FC5H,00FACH,00F94H,00F7CH,00F64H,00F4DH,00F35H ;241.2-241.9°
DW      00F1DH,00F05H,00EEEH,00ED6H,00EBFH,00EA7H,00E90H,00E79H ;241.9-242.6°
DW      00E62H,00E4BH,00E34H,00E1DH,00E06H,00DEFH,00DD8H,00DC1H ;242.6-243.3°
DW      00DABH,00D94H,00D7EH,00D67H,00D51H,00D3BH,00D24H,00D0EH ;243.3-244.0°
DW      00CF8H,00CE2H,00CCCH,00CB6H,00CA1H,00C8BH,00C75H,00C60H ;244.0-244.7°
DW      00C4AH,00C35H,00C1FH,00C0AH,00BF5H,00BDFH,00BCAH,00BB5H ;244.7-245.4°
DW      00BA0H,00B8BH,00B77H,00B62H,00B4DH,00B39H,00B24H,00B0FH ;245.4-246.1°
DW      00AFBH,00AE7H,00AD2H,00ABEH,00AAAH,00A96H,00A82H,00A6EH ;246.1-246.8°
DW      00A5AH,00A47H,00A33H,00A1FH,00A0CH,009F8H,009E5H,009D2H ;246.8-247.5°
DW      009BEH,009ABH,00998H,00985H,00972H,0095FH,0094CH,00939H ;247.5-248.2°
DW      00927H,00914H,00901H,008EFH,008DDH,008CAH,008B8H,008A6H ;248.2-248.9°
DW      00894H,00882H,00870H,0085EH,0084CH,0083AH,00828H,00817H ;248.9-249.6°
DW      00805H,007F4H,007E2H,007D1H,007C0H,007AFH,0079DH,0078CH ;249.6-250.3°
DW      0077BH,0076BH,0075AH,00749H,00738H,00728H,00717H,00707H ;250.3-251.0°
DW      006F6H,006E6H,006D6H,006C6H,006B5H,006A5H,00695H,00686H ;251.0-251.7°
DW      00676H,00666H,00656H,00647H,00637H,00628H,00619H,00609H ;251.7-252.4°
DW      005FAH,005EBH,005DCH,005CDH,005BEH,005AFH,005A0H,00592H ;252.4-253.1°
DW      00583H,00574H,00566H,00557H,00549H,0053BH,0052DH,0051FH ;253.1-253.8°
DW      00511H,00503H,004F5H,004E7H,004D9H,004CCH,004BEH,004B0H ;253.8-254.5°
DW      004A3H,00496H,00488H,0047BH,0046EH,00461H,00454H,00447H ;254.5-255.2°
DW      0043AH,0042DH,00421H,00414H,00407H,003FBH,003EFH,003E2H ;255.2-255.9°
DW      003D6H,003CAH,003BEH,003B2H,003A6H,0039AH,0038EH,00382H ;255.9-256.6°
DW      00377H,0036BH,00360H,00354H,00349H,0033EH,00332H,00327H ;256.6-257.3°
DW      0031CH,00311H,00306H,002FBH,002F1H,002E6H,002DBH,002D1H ;257.3-258.0°
DW      002C6H,002BCH,002B2H,002A8H,0029DH,00293H,00289H,0027FH ;258.0-258.8°
DW      00276H,0026CH,00262H,00259H,0024FH,00246H,0023CH,00233H ;258.8-259.5°
DW      0022AH,00220H,00217H,0020EH,00205H,001FDH,001F4H,001EBH ;259.5-260.2°
DW      001E2H,001DAH,001D1H,001C9H,001C1H,001B8H,001B0H,001A8H ;260.2-260.9°
DW      001A0H,00198H,00190H,00188H,00181H,00179H,00172H,0016AH ;260.9-261.6°
DW      00163H,0015BH,00154H,0014DH,00146H,0013FH,00138H,00131H ;261.6-262.3°
DW      0012AH,00123H,0011DH,00116H,00110H,00109H,00103H,000FDH ;262.3-263.0°
DW      000F6H,000F0H,000EAH,000E4H,000DEH,000D9H,000D3H,000CDH ;263.0-263.7°
DW      000C8H,000C2H,000BDH,000B7H,000B2H,000ADH,000A8H,000A3H ;263.7-264.4°
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DW      0009EH,00099H,00094H,0008FH,0008BH,00086H,00082H,0007DH ;264.4-265.1°
DW      00079H,00075H,00070H,0006CH,00068H,00064H,00060H,0005DH ;265.1-265.8°
DW      00059H,00055H,00052H,0004EH,0004BH,00047H,00044H,00041H ;265.8-266.5°
DW      0003EH,0003BH,00038H,00035H,00032H,0002FH,0002DH,0002AH ;266.5-267.2°
DW      00027H,00025H,00023H,00020H,0001EH,0001CH,0001AH,00018H ;267.2-267.9°
DW      00016H,00014H,00013H,00011H,0000FH,0000EH,0000CH,0000BH ;267.9-268.6°
DW      0000AH,00009H,00008H,00007H,00006H,00005H,00004H,00003H ;268.6-269.3°
DW      00002H,00002H,00001H,00001H,00001H,00000H,00000H,00000H ;269.3-270.0°
DW      00000H,00000H,00000H,00000H,00001H,00001H,00001H,00002H ;270.0-270.7°
DW      00002H,00003H,00004H,00005H,00006H,00007H,00008H,00009H ;270.7-271.4°
DW      0000AH,0000BH,0000CH,0000EH,0000FH,00011H,00013H,00014H ;271.4-272.1°
DW      00016H,00018H,0001AH,0001CH,0001EH,00020H,00023H,00025H ;272.1-272.8°
DW      00027H,0002AH,0002DH,0002FH,00032H,00035H,00038H,0003BH ;272.8-273.5°
DW      0003EH,00041H,00044H,00047H,0004BH,0004EH,00052H,00055H ;273.5-274.2°
DW      00059H,0005DH,00060H,00064H,00068H,0006CH,00070H,00075H ;274.2-274.9°
DW      00079H,0007DH,00082H,00086H,0008BH,0008FH,00094H,00099H ;274.9-275.6°
DW      0009EH,000A3H,000A8H,000ADH,000B2H,000B7H,000BDH,000C2H ;275.6-276.3°
DW      000C8H,000CDH,000D3H,000D9H,000DEH,000E4H,000EAH,000F0H ;276.3-277.0°
DW      000F6H,000FDH,00103H,00109H,00110H,00116H,0011DH,00123H ;277.0-277.7°
DW      0012AH,00131H,00138H,0013FH,00146H,0014DH,00154H,0015BH ;277.7-278.4°
DW      00163H,0016AH,00172H,00179H,00181H,00188H,00190H,00198H ;278.4-279.1°
DW      001A0H,001A8H,001B0H,001B8H,001C1H,001C9H,001D1H,001DAH ;279.1-279.8°
DW      001E2H,001EBH,001F4H,001FDH,00205H,0020EH,00217H,00220H ;279.8-280.5°
DW      0022AH,00233H,0023CH,00246H,0024FH,00259H,00262H,0026CH ;280.5-281.3°
DW      00276H,0027FH,00289H,00293H,0029DH,002A8H,002B2H,002BCH ;281.3-282.0°
DW      002C6H,002D1H,002DBH,002E6H,002F1H,002FBH,00306H,00311H ;282.0-282.7°
DW      0031CH,00327H,00332H,0033EH,00349H,00354H,00360H,0036BH ;282.7-283.4°
DW      00377H,00382H,0038EH,0039AH,003A6H,003B2H,003BEH,003CAH ;283.4-284.1°
DW      003D6H,003E2H,003EFH,003FBH,00407H,00414H,00421H,0042DH ;284.1-284.8°
DW      0043AH,00447H,00454H,00461H,0046EH,0047BH,00488H,00496H ;284.8-285.5°
DW      004A3H,004B0H,004BEH,004CCH,004D9H,004E7H,004F5H,00503H ;285.5-286.2°
DW      00511H,0051FH,0052DH,0053BH,00549H,00557H,00566H,00574H ;286.2-286.9°
DW      00583H,00592H,005A0H,005AFH,005BEH,005CDH,005DCH,005EBH ;286.9-287.6°
DW      005FAH,00609H,00619H,00628H,00637H,00647H,00656H,00666H ;287.6-288.3°
DW      00676H,00686H,00695H,006A5H,006B5H,006C6H,006D6H,006E6H ;288.3-289.0°
DW      006F6H,00707H,00717H,00728H,00738H,00749H,0075AH,0076BH ;289.0-289.7°
DW      0077BH,0078CH,0079DH,007AFH,007C0H,007D1H,007E2H,007F4H ;289.7-290.4°
DW      00805H,00817H,00828H,0083AH,0084CH,0085EH,00870H,00882H ;290.4-291.1°
DW      00894H,008A6H,008B8H,008CAH,008DDH,008EFH,00901H,00914H ;291.1-291.8°
DW      00927H,00939H,0094CH,0095FH,00972H,00985H,00998H,009ABH ;291.8-292.5°
DW      009BEH,009D2H,009E5H,009F8H,00A0CH,00A1FH,00A33H,00A47H ;292.5-293.2°
DW      00A5AH,00A6EH,00A82H,00A96H,00AAAH,00ABEH,00AD2H,00AE7H ;293.2-293.9°
DW      00AFBH,00B0FH,00B24H,00B39H,00B4DH,00B62H,00B77H,00B8BH ;293.9-294.6°
DW      00BA0H,00BB5H,00BCAH,00BDFH,00BF5H,00C0AH,00C1FH,00C35H ;294.6-295.3°
DW      00C4AH,00C60H,00C75H,00C8BH,00CA1H,00CB6H,00CCCH,00CE2H ;295.3-296.0°
DW      00CF8H,00D0EH,00D24H,00D3BH,00D51H,00D67H,00D7EH,00D94H ;296.0-296.7°
DW      00DABH,00DC1H,00DD8H,00DEFH,00E06H,00E1DH,00E34H,00E4BH ;296.7-297.4°
DW      00E62H,00E79H,00E90H,00EA7H,00EBFH,00ED6H,00EEEH,00F05H ;297.4-298.1°
DW      00F1DH,00F35H,00F4DH,00F64H,00F7CH,00F94H,00FACH,00FC5H ;298.1-298.8°
DW      00FDDH,00FF5H,0100DH,01026H,0103EH,01057H,0106FH,01088H ;298.8-299.5°
DW      010A1H,010BAH,010D3H,010EBH,01104H,0111EH,01137H,01150H ;299.5-300.2°
DW      01169H,01183H,0119CH,011B5H,011CFH,011E9H,01202H,0121CH ;300.2-300.9°
DW      01236H,01250H,0126AH,01284H,0129EH,012B8H,012D2H,012ECH ;300.9-301.6°
DW      01307H,01321H,0133CH,01356H,01371H,0138BH,013A6H,013C1H ;301.6-302.3°
DW      013DCH,013F7H,01412H,0142DH,01448H,01463H,0147EH,0149AH ;302.3-303.0°
DW      014B5H,014D0H,014ECH,01507H,01523H,0153FH,0155BH,01576H ;303.0-303.8°
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DW      01592H,015AEH,015CAH,015E6H,01602H,0161FH,0163BH,01657H ;303.8-304.5°
DW      01674H,01690H,016ADH,016C9H,016E6H,01703H,0171FH,0173CH ;304.5-305.2°
DW      01759H,01776H,01793H,017B0H,017CDH,017EBH,01808H,01825H ;305.2-305.9°
DW      01843H,01860H,0187EH,0189BH,018B9H,018D7H,018F5H,01912H ;305.9-306.6°
DW      01930H,0194EH,0196CH,0198AH,019A9H,019C7H,019E5H,01A03H ;306.6-307.3°
DW      01A22H,01A40H,01A5FH,01A7DH,01A9CH,01ABBH,01ADAH,01AF8H ;307.3-308.0°
DW      01B17H,01B36H,01B55H,01B74H,01B93H,01BB3H,01BD2H,01BF1H ;308.0-308.7°
DW      01C11H,01C30H,01C50H,01C6FH,01C8FH,01CAEH,01CCEH,01CEEH ;308.7-309.4°
DW      01D0EH,01D2EH,01D4EH,01D6EH,01D8EH,01DAEH,01DCEH,01DEEH ;309.4-310.1°
DW      01E0FH,01E2FH,01E50H,01E70H,01E91H,01EB1H,01ED2H,01EF3H ;310.1-310.8°
DW      01F14H,01F34H,01F55H,01F76H,01F97H,01FB8H,01FDAH,01FFBH ;310.8-311.5°
DW      0201CH,0203DH,0205FH,02080H,020A2H,020C3H,020E5H,02107H ;311.5-312.2°
DW      02128H,0214AH,0216CH,0218EH,021B0H,021D2H,021F4H,02216H ;312.2-312.9°
DW      02238H,0225AH,0227DH,0229FH,022C1H,022E4H,02306H,02329H ;312.9-313.6°
DW      0234CH,0236EH,02391H,023B4H,023D7H,023FAH,0241DH,02440H ;313.6-314.3°
DW      02463H,02486H,024A9H,024CCH,024F0H,02513H,02536H,0255AH ;314.3-315.0°
DW      0257DH,025A1H,025C4H,025E8H,0260CH,02630H,02653H,02677H ;315.0-315.7°
DW      0269BH,026BFH,026E3H,02707H,0272CH,02750H,02774H,02798H ;315.7-316.4°
DW      027BDH,027E1H,02806H,0282AH,0284FH,02874H,02898H,028BDH ;316.4-317.1°
DW      028E2H,02907H,0292CH,02950H,02975H,0299BH,029C0H,029E5H ;317.1-317.8°
DW      02A0AH,02A2FH,02A55H,02A7AH,02A9FH,02AC5H,02AEAH,02B10H ;317.8-318.5°
DW      02B36H,02B5BH,02B81H,02BA7H,02BCDH,02BF3H,02C18H,02C3EH ;318.5-319.2°
DW      02C64H,02C8BH,02CB1H,02CD7H,02CFDH,02D23H,02D4AH,02D70H ;319.2-319.9°
DW      02D97H,02DBDH,02DE4H,02E0AH,02E31H,02E57H,02E7EH,02EA5H ;319.9-320.6°
DW      02ECCH,02EF3H,02F1AH,02F41H,02F68H,02F8FH,02FB6H,02FDDH ;320.6-321.3°
DW      03004H,0302BH,03053H,0307AH,030A2H,030C9H,030F1H,03118H ;321.3-322.0°
DW      03140H,03167H,0318FH,031B7H,031DFH,03206H,0322EH,03256H ;322.0-322.7°
DW      0327EH,032A6H,032CEH,032F6H,0331FH,03347H,0336FH,03397H ;322.7-323.4°
DW      033C0H,033E8H,03411H,03439H,03462H,0348AH,034B3H,034DBH ;323.4-324.1°
DW      03504H,0352DH,03556H,0357FH,035A7H,035D0H,035F9H,03622H ;324.1-324.8°
DW      0364BH,03675H,0369EH,036C7H,036F0H,0371AH,03743H,0376CH ;324.8-325.5°
DW      03796H,037BFH,037E9H,03812H,0383CH,03865H,0388FH,038B9H ;325.5-326.3°
DW      038E3H,0390CH,03936H,03960H,0398AH,039B4H,039DEH,03A08H ;326.3-327.0°
DW      03A32H,03A5CH,03A87H,03AB1H,03ADBH,03B06H,03B30H,03B5AH ;327.0-327.7°
DW      03B85H,03BAFH,03BDAH,03C04H,03C2FH,03C5AH,03C84H,03CAFH ;327.7-328.4°
DW      03CDAH,03D05H,03D2FH,03D5AH,03D85H,03DB0H,03DDBH,03E06H ;328.4-329.1°
DW      03E31H,03E5DH,03E88H,03EB3H,03EDEH,03F09H,03F35H,03F60H ;329.1-329.8°
DW      03F8CH,03FB7H,03FE2H,0400EH,0403AH,04065H,04091H,040BCH ;329.8-330.5°
DW      040E8H,04114H,04140H,0416CH,04197H,041C3H,041EFH,0421BH ;330.5-331.2°
DW      04247H,04273H,0429FH,042CCH,042F8H,04324H,04350H,0437CH ;331.2-331.9°
DW      043A9H,043D5H,04401H,0442EH,0445AH,04487H,044B3H,044E0H ;331.9-332.6°
DW      0450DH,04539H,04566H,04593H,045BFH,045ECH,04619H,04646H ;332.6-333.3°
DW      04673H,0469FH,046CCH,046F9H,04726H,04754H,04781H,047AEH ;333.3-334.0°
DW      047DBH,04808H,04835H,04863H,04890H,048BDH,048EAH,04918H ;334.0-334.7°
DW      04945H,04973H,049A0H,049CEH,049FBH,04A29H,04A57H,04A84H ;334.7-335.4°
DW      04AB2H,04AE0H,04B0DH,04B3BH,04B69H,04B97H,04BC5H,04BF3H ;335.4-336.1°
DW      04C20H,04C4EH,04C7CH,04CAAH,04CD9H,04D07H,04D35H,04D63H ;336.1-336.8°
DW      04D91H,04DBFH,04DEEH,04E1CH,04E4AH,04E78H,04EA7H,04ED5H ;336.8-337.5°
DW      04F04H,04F32H,04F61H,04F8FH,04FBEH,04FECH,0501BH,05049H ;337.5-338.2°
DW      05078H,050A7H,050D5H,05104H,05133H,05162H,05191H,051BFH ;338.2-338.9°
DW      051EEH,0521DH,0524CH,0527BH,052AAH,052D9H,05308H,05337H ;338.9-339.6°
DW      05366H,05395H,053C5H,053F4H,05423H,05452H,05482H,054B1H ;339.6-340.3°
DW      054E0H,0550FH,0553FH,0556EH,0559EH,055CDH,055FDH,0562CH ;340.3-341.0°
DW      0565CH,0568BH,056BBH,056EAH,0571AH,0574AH,05779H,057A9H ;341.0-341.7°
DW      057D9H,05808H,05838H,05868H,05898H,058C8H,058F7H,05927H ;341.7-342.4°
DW      05957H,05987H,059B7H,059E7H,05A17H,05A47H,05A77H,05AA7H ;342.4-343.1°
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DW      05AD7H,05B07H,05B37H,05B68H,05B98H,05BC8H,05BF8H,05C28H ;343.1-343.8°
DW      05C59H,05C89H,05CB9H,05CEAH,05D1AH,05D4AH,05D7BH,05DABH ;343.8-344.5°
DW      05DDCH,05E0CH,05E3DH,05E6DH,05E9EH,05ECEH,05EFFH,05F2FH ;344.5-345.2°
DW      05F60H,05F90H,05FC1H,05FF2H,06022H,06053H,06084H,060B5H ;345.2-345.9°
DW      060E5H,06116H,06147H,06178H,061A8H,061D9H,0620AH,0623BH ;345.9-346.6°
DW      0626CH,0629DH,062CEH,062FFH,06330H,06361H,06392H,063C3H ;346.6-347.3°
DW      063F4H,06425H,06456H,06487H,064B8H,064E9H,0651AH,0654BH ;347.3-348.0°
DW      0657DH,065AEH,065DFH,06610H,06641H,06673H,066A4H,066D5H ;348.0-348.8°
DW      06706H,06738H,06769H,0679AH,067CCH,067FDH,0682FH,06860H ;348.8-349.5°
DW      06891H,068C3H,068F4H,06926H,06957H,06989H,069BAH,069ECH ;349.5-350.2°
DW      06A1DH,06A4FH,06A80H,06AB2H,06AE3H,06B15H,06B46H,06B78H ;350.2-350.9°
DW      06BAAH,06BDBH,06C0DH,06C3FH,06C70H,06CA2H,06CD4H,06D05H ;350.9-351.6°
DW      06D37H,06D69H,06D9BH,06DCCH,06DFEH,06E30H,06E62H,06E93H ;351.6-352.3°
DW      06EC5H,06EF7H,06F29H,06F5BH,06F8DH,06FBEH,06FF0H,07022H ;352.3-353.0°
DW      07054H,07086H,070B8H,070EAH,0711CH,0714EH,0717FH,071B1H ;353.0-353.7°
DW      071E3H,07215H,07247H,07279H,072ABH,072DDH,0730FH,07341H ;353.7-354.4°
DW      07373H,073A5H,073D7H,07409H,0743BH,0746DH,074A0H,074D2H ;354.4-355.1°
DW      07504H,07536H,07568H,0759AH,075CCH,075FEH,07630H,07662H ;355.1-355.8°
DW      07695H,076C7H,076F9H,0772BH,0775DH,0778FH,077C1H,077F4H ;355.8-356.5°
DW      07826H,07858H,0788AH,078BCH,078EEH,07921H,07953H,07985H ;356.5-357.2°
DW      079B7H,079E9H,07A1CH,07A4EH,07A80H,07AB2H,07AE4H,07B17H ;357.2-357.9°
DW      07B49H,07B7BH,07BADH,07BE0H,07C12H,07C44H,07C76H,07CA9H ;357.9-358.6°
DW      07CDBH,07D0DH,07D3FH,07D72H,07DA4H,07DD6H,07E08H,07E3BH ;358.6-359.3°
DW      07E6DH,07E9FH,07ED1H,07F04H,07F36H,07F68H,07F9AH,07FCDH ;359.3-360.0°
```

(2) Target frequency table

```
          ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
          ;TT    Target frequency table (157*2 bytes)          TT
          ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
          ;    Table data = (target frequency)
FRQTBL:
DB          0,   1,   2,   3,   4,   5,   6,   7,   8,   9
DB         10,  11,  12,  13,  14,  15,  16,  17,  18,  19
DB         20,  21,  22,  23,  24,  25,  26,  27,  28,  29
DB         30,  31,  32,  33,  34,  35,  36,  37,  38,  39
DB         40,  41,  42,  43,  44,  45,  46,  47,  48,  49
DB         50,  51,  52,  53,  54,  55,  56,  57,  58,  59
DB         60,  61,  62,  63,  64,  65,  66,  67,  68,  69
DB         70,  71,  72,  73,  74,  75,  76,  77,  78,  79
DB         80,  81,  82,  83,  84,  85,  86,  87,  88,  89
DB         90,  91,  92,  93,  94,  95,  96,  97,  98,  99
DB        100, 101, 102, 103, 104, 105, 106, 107, 108, 109
DB        110, 111, 112, 113, 114, 115, 116, 117, 118, 119
DB        120, 121, 122, 123, 124, 125, 126, 127, 128, 129
DB        130, 131, 132, 133, 134, 135, 136, 137, 138, 139
DB        140, 141, 142, 143, 144, 145, 146, 147, 148, 149
DB        150, 151, 152, 153, 154, 155, 156, 157, 158, 159
DB        160
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(3) Carrier frequency table

```
          ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
          ;TT     Carrier frequency table (10*2 bytes)          TT
          ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
          ;    Table data = (carrier frequency [Hz])
CRRYTBL:
DW            0,  200,  400,  600,  800, 1000, 1200, 1400, 1600, 1800
DW         2000, 2200, 2400, 2600, 2800, 3000, 3200, 3400, 3600, 3800
DW         4000, 4200, 4400, 4600, 4800, 5000, 5200, 5400, 5600, 5800
DW         6000, 6200, 6400, 6600, 6800, 7000, 7200, 7400, 7600, 7800
DW         8000, 8200, 8400, 8600, 8800, 9000, 9200, 9400, 9600, 9800
DW        10000,10200,10400,10600,10800,11000,11200,11400,11600,11800
DW        12000,12200,12400,12600,12800,13000,13200,13400,13600,13800
DW        14000,14200,14400,14600,14800,15000,15200,15400,15600,15800
DW        16000,16200,16400,16600,16800,17000,17200,17400,17600,17800
DW        18000,18200,18400,18600,18800,19000,19200,19400,19600,19800
DW        20000
```

(4) Maximum frequency limit table

```
          ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
          ;TT     Maximum frequency limit table              TT
          ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
          ;    Table data = (output frequency number)
FMXTBL:   ; +0.2 +0.4 +0.6 +0.8 +1.0 +1.2 +1.4 +1.6 +1.8 +2.0
DB        0, 25,  50,  75, 100, 120, 140, 160, 160, 160, 160   ;  0[kHz]
DB          160, 160, 160, 160, 160, 160, 160, 160, 160, 160   ;  2
DB          160, 160, 160, 160, 160, 160, 160, 160, 160, 160   ;  4
DB          160, 160, 160, 160, 160, 160, 160, 160, 160, 160   ;  6
DB          160, 160, 160, 160, 160, 160, 160, 160, 160, 160   ;  8
DB          160, 160, 160, 160, 160, 160, 160, 160, 160, 160   ; 10
DB          160, 160, 160, 160, 160, 160, 160, 160, 160, 160   ; 12
DB          160, 160, 160, 160, 160, 160, 160, 160, 160, 160   ; 14
DB          160, 160, 160, 160, 160, 160, 160, 160, 160, 160   ; 16
DB          160, 160, 160, 160, 160, 160, 160, 160, 160, 160   ; 18
DB          160, 160, 160, 160, 160, 160, 160, 160, 160, 160   ; 20
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(5) Maximum dead time limit table

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          ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
          ;TT     Maximum dead time limit table              TT
          ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
          ;    Table data = (dead time number)
DMXTBL:   ; +0.2 +0.4 +0.6 +0.8 +1.0 +1.2 +1.4 +1.6 +1.8 +2.0
DB        0, 50,  50,  50,  50,  50,  50,  50,  50,  50,  50   ;  0[kHz]
DB           50,  50,  50,  50,  50,  50,  50,  50,  50,  50   ;  2
DB           50,  50,  50,  50,  50,  50,  50,  50,  50,  50   ;  4
DB           50,  50,  50,  50,  50,  50,  50,  50,  50,  50   ;  6
DB           50,  48,  48,  48,  46,  46,  44,  44,  42,  42   ;  8
DB           42,  40,  40,  40,  38,  38,  38,  36,  36,  36   ; 10
DB           34,  34,  34,  34,  32,  32,  32,  32,  32,  30   ; 12
DB           30,  30,  30,  30,  28,  28,  28,  28,  28,  26   ; 14
DB           26,  26,  26,  26,  26,  26,  24,  24,  24,  24   ; 16
DB           24,  24,  24,  22,  22,  22,  22,  22,  22,  22   ; 18
```

(6) V/f modulation ratio table

```
            ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
            ;TT   V/f modulation ratio table No. 1 (157*2 bytes)  TT
            ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
            ;   Table data = (modulation ratio)*1000H
VFTBL1:     ; +0    +1    +2    +3    +4    +5    +6    +7    +8    +9    [Hz]
DW                                  053FH,0571H,05A2H,05D3H,0604H,0635H ;   0 Hz
DW          0666H,0698H,06C9H,06FAH,072BH,075CH,078DH,07BEH,07F0H,0821H ;  10
DW          0852H,0883H,08B4H,08E5H,0917H,0948H,0979H,09AAH,09DBH,0A0CH ;  20
DW          0A3DH,0A6FH,0AA0H,0AD1H,0B02H,0B33H,0B64H,0B96H,0BC7H,0BF8H ;  30
DW          0C29H,0C5AH,0C8BH,0CBCH,0CEEH,0D1FH,0D50H,0D81H,0DB2H,0DE3H ;  40
DW          0E14H,0E46H,0E77H,0EA8H,0ED9H,0F0AH,0F3BH,0F6DH,0F9EH,0FCFH ;  50
DW          1000H,1031H,1062H,1093H,10C5H,10F6H,1127H,1158H,1189H,11BAH ;  60
DW          11ECH,121DH,124EH,127FH,12B0H,12E1H,1312H,1344H,1375H,13A6H ;  70
DW          13D7H,1408H,1439H,146AH,149CH,14CDH,14FEH,152FH,1560H,1591H ;  80
DW          15C3H,15F4H,1625H,1656H,1687H,16B8H,16E9H,171BH,174CH,177DH ;  90
DW          17AEH,17DFH,1810H,1842H,1873H,18A4H,18D5H,1906H,1937H,1968H ; 100
DW          199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH ; 110
DW          199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH ; 120
DW          199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH ; 130
DW          199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH ; 140
DW          199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH,199AH ; 150
DW          199AH                                                       ; 160
```

(7) Change rate table

```
            ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
            ;TT   Change rate table                     TT
            ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
CHDSPTBL:             ;************ Display table
DB              5,    10,    15,    20
CHNGTBL:              ;************ Counter table
DW            400,   200,   133,   100
```

(8) Dead time table

```
            ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
            ;TT   Dead time table                       TT
            ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
            ;   Table data = (dead time [μs])
DEADTBL:
DB           0,  1,  2,  3,  4,  5,  6,  7,  8,  9
DB          10, 11, 12, 13, 14, 15, 16, 17, 18, 19
DB          20, 21, 22, 23, 24, 25, 26, 27, 28, 29
DB          30, 31, 32, 33, 34, 35, 36, 37, 38, 39
DB          40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
```

(9) Change pattern table

```
          ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
          ;TT       Change pattern table                TT
          ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
PTNTBL:   ;************ Change pattern start address
DW        PTRN1,    PTRN2,    PTRN3,    PTRN4,    PTRN5
DW        PTRN6,    PTRN7,    PTRN8,    PTRN9,    PTRN10

PTRN1:    ;************ Change pattern No.1
DB         4,01,0   ; Initial setting
DB         4,0FFH

PTRN2:    ;************ Change pattern No.2
DB        11,03,0   ; Initial setting
DB         4,01,0,   7,02,0,  10,03,0,  11,0FFH

PTRN3:    ;************ Change pattern No.3
DB        21,06,1   ; Initial setting
DB         4,01,1,   7,02,1,  10,03,1,  13,04,1,  16,05,1,  19,06,1,  21,0FFH

PTRN4:    ;************ Change pattern No.4
DB        31,09,3   ; Initial setting
DB         4,01,3,   7,02,3,  10,03,3,  13,04,3,  16,05,3,  19,06,3,  22,07,3
DB        25,08,3,  28,09,3,  31,0FFH

PTRN5:    ;************ Change pattern No.5
DB        11,07,0   ; Initial setting
DB         4,01,0,   5,02,0,   6,03,0,   7,04,0,   8,05,0,   9,06,0,  10,07,0
DB        11,0FFH

PTRN6:    ;************ Change pattern No.6
DB        21,17,1   ; Initial setting
DB         4,01,1,   5,02,1,   6,03,1,   7,04,1,   8,05,1,   9,06,1,  10,07,1
DB        11,08,1,  12,09,1,  13,10,1,  14,11,1,  15,12,1,  16,13,1,  17,14,1
DB        18,15,1,  19,16,1,  20,17,1,  21,0FFH

PTRN7:    ;************ Change pattern No.7
DB        31,27,3   ; Initial setting
DB         4,01,2,   5,02,2,   6,03,2,   7,04,2,   8,05,2,   9,06,2,  10,07,2
DB        11,08,2,  12,09,2,  13,10,2,  14,11,2,  15,12,2,  16,13,2,  17,14,2
DB        18,15,2,  19,16,2,  20,17,2,  21,18,2,  22,19,2,  23,20,2,  24,21,2
DB        25,22,2,  26,23,2,  27,24,2,  28,25,2,  29,26,2,  30,27,2,  31,0FFH

PTRN8:    ;************ Change pattern No.8
DB        11,14,0   ; Initial setting
DB         4,02,0,   5,04,0,   6,06,0,   7,08,0,   8,10,0,   9,12,0,  10,14,0
DB        11,0FFH

PTRN9:    ;************ Change pattern No.9
DB        21,34,1   ; Initial setting
DB         4,02,1,   5,04,1,   6,06,1,   7,08,1,   8,10,1,   9,12,1,  10,14,1
DB        11,16,1,  12,18,1,  13,20,1,  14,22,1,  15,24,1,  16,26,1,  17,28,1
DB        18,30,1,  19,32,1,  20,34,1,  21,0FFH
```

```
PTRN10:  ;************ Change pattern No.10
DB       31,54,3   ; Initial setting
DB        4,02,3,  5,04,3,  6,06,3,  7,08,3,  8,10,3,  9,12,3, 10,14,3
DB       11,16,3, 12,18,3, 13,20,3, 14,22,3, 15,24,3, 16,26,3, 17,28,3
DB       18,30,3, 19,32,3, 20,34,3, 21,36,3, 22,38,3, 23,40,3, 24,42,3
DB       25,44,3, 26,46,3, 27,48,3, 28,50,3, 29,52,3, 30,54,3, 31,0FFH
```

(10) Display pattern table

```
         ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
         ;TT      Display pattern table                    TT
         ;TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
LEDTBL:  ; 0    1    2    3    4    5    6    7    8    9
DB        0B7H,006H,073H,057H,0C6H,0D5H,0F5H,087H,0F7H,0D7H
         ; d    o    P    _
DB        076H,074H,0E3H,000H,000H,000H
         ; 0.   1.   2.   3.   4.   5.   6.   7.   8.   9.
DB        0BFH,00EH,07BH,05FH,0CEH,0DDH,0FDH,08FH,0FFH,0DFH

         END
```

6.4 CONSTANT DEFINITION

```
          ;CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
          ;CC       Constant definition                 CC
          ;CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
FRQWAIT   EQU       99              ; Frequency change wait
FRQSTOP   EQU       0FFH            ; Output stop setting
FOUTINI   EQU       004H            ; Initial value of output frequency
DEADMN1   EQU       05              ;
VFPINI    EQU (FOUTINI-4)*2         ; Initial value of V/f modulation ratio pointer
ADDADR    EQU       2730            ; Inter-phase step address (4096/3 * 2)
KONINI    EQU       100             ; Initial value of hold-down counter
KONRES    EQU       19              ; Re-set value of hold-down counter
KSMPINI   EQU       2               ; Key input sampling interval
PSMPINI   EQU       2               ; Stop signal sampling interval
SEGINI    EQU       100             ; 8-segment LED flash cycle
LEDINI    EQU       100             ; LED flash cycle
MLWAIT    EQU       4999            ; Main frequency (CM10)
PMSTOP    EQU       0               ; Main mode:  Signal output stop
PMFOUT    EQU       1               ; Main mode:  Fixed frequency output
PMCHNG    EQU       2               ; Main mode:  Output frequency change
SMOUT     EQU       0               ; Key setting mode:  PWM output setting
SMOFF     EQU       1               ; Key setting mode:  Off
SMPTN     EQU       2               ; Key setting mode:  Change pattern
KNULL     EQU       0               ; Key code:  Null
KCHNG     EQU       1               ; Key code:  [Changeover]
KMINS     EQU       2               ; Key code:  [-]
KPLUS     EQU       3               ; Key code:  [+]
KONOF     EQU       4               ; Key code:  [ON/OFF]
KERR      EQU       10H             ; Key code:  Non-matching
DMFOUT    EQU       10H             ; 8-segment LED display mode:  Output frequency
DMCRRY    EQU       11H             ; 8-segment LED display mode:  Carrier frequency
DMDEAD    EQU       12H             ; 8-segment LED display mode:  Dead time
DMCHNG    EQU       03H             ; 8-segment LED display mode:  Rate of frequency change
DMPTRN    EQU       04H             ; 8-segment LED display mode:  Change pattern
CHRD      EQU       0AH             ; "d" pattern code
CHRO      EQU       0BH             ; "o" pattern code
CHRP      EQU       0CH             ; "P" pattern code
CHRSPC    EQU       0DH             ; " " pattern code
CHRZ      EQU       10H             ; "0." pattern code

TM0WADR   EQU       0FE8EH          ; INTTM0 table reference address work register
PCSTK7    EQU       0FE84H          ; INTTM0 PC stack
```

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