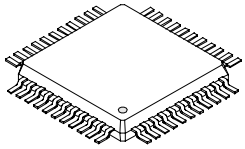
1/4 to 1/11 DUTY FIP(VFD) CONTROLLER/DRIVER



QPF-44-10x10-0.8

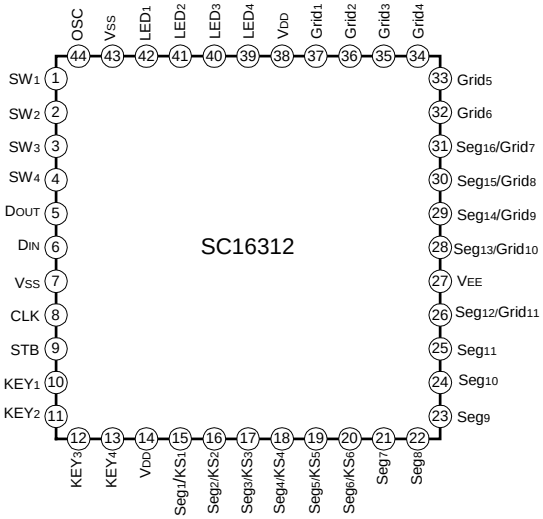
DESCRIPTION

The SC16312 is a FIP (Fluorescent Indicator Panel, or Vacuum Fluorescent Display) controller/driver that is driven on a 1/4 or 1/11 duty factor. It consists of 11 segment output lines, 6 grid output lines, 5 segment/grid output drive lines, a display memory, a control circuit, and a key scan circuit. Serial data is input to the SC16312 through a three-line serial interface. This FIP controller/driver is ideal as a peripheral device for a single-chip microcomputer.

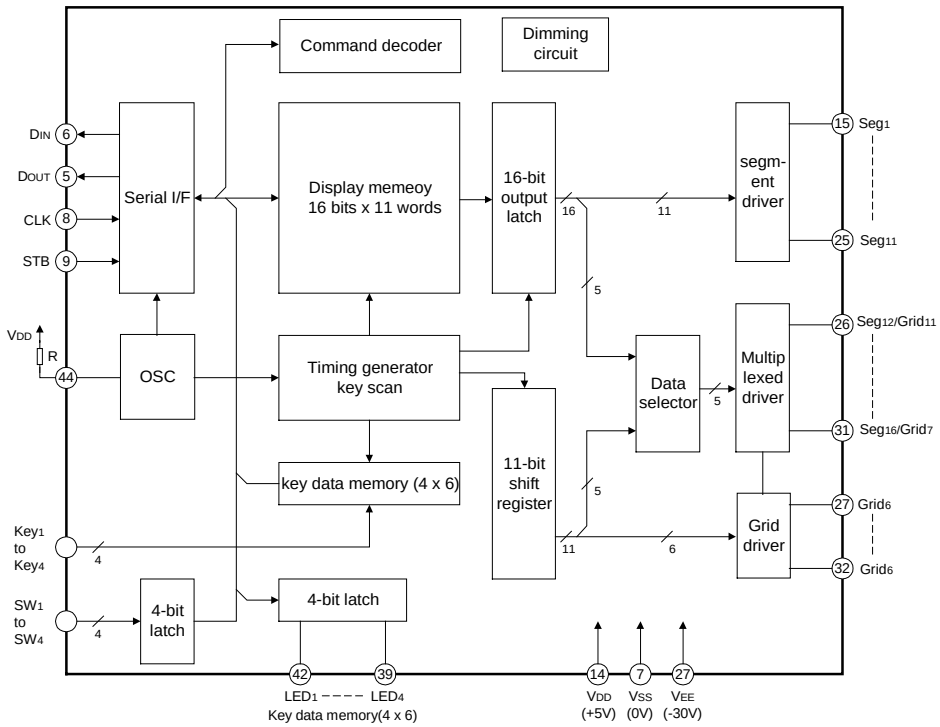
FEATURES

* Multiple display modes (11-segment & 11-dight to 16-segment & 4-digit).
* Key scanning (6x4 matrix).
* Dimming circuit (eight steps).
* High-voltage output (V_{DD} – 35V max).
* LED ports (4 chs., 20 mA max).
* General-purpose input port (4 bits)
* No external resistors necessary for driver outputs (P-ch open-drain + pull-down resistor output)
* Serial interface (CLK, STB, DIN, DOUT)

PAD CONFIGURATION



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATING (Ta=25°C, Vss=0V)

Characteristic	Symbol	Value	Unit
Logic Supply Voltage	V_{DD}	-0.5 ~ 7.0	V
Driver Supply Voltage	V_{EE}	V_{DD} + 0.5 ~ V_{DD} - 40	V
Logic Input Voltage	V_{I1}	-0.5 ~ V_{DD} + 0.5	V
FIP Driver Output Voltage	V_{O2}	V_{EE} - 0.5 ~ V_{DD} + 0.5	V
LED Driver Output Current	I_{O1}	+25	mA
FIP Driver Output Current	I_{O2}	-40 (grid) ; -15 (segment)	mA
Power Dissipation	P_D	800 *	mW
Storage temperature	T_{STG}	-65 ~ +150	°C
Operating Ambient Temperature	T_{OPT}	-40 ~ + 85	°C

* Note: Derate at –6.4 mW/°C at Ta=25°C or higher

RECOMMENDED OPERATING RANGE (Ta=-20 ~ 70 °C, Vss=0V)

Parameter	Symbol	Min	Typ	Max	Unit
Logic Supply Voltage	V_{DD}	4.5	5	5.5	V
High-Level Input Voltage	V_{IH}	0.7x V_{DD}	--	V_{DD}	V
Low-Level Input Voltage	V_{IL}	0	--	0.3xV_{DD}	V
Driver Supply Voltage	V_{EE}	0	--	V_{DD}-35	V

Maximum power consumption $P_{MAX.}$ = FIP driver dissipation + R_L dissipation + LED driver dissipation + dynamic power consumption

Where segment current = 3mA, grid current = 15mA, and LED current = 20mA,

FIP driver dissipation = number of segments x 6 + number of grids/(number of grids + 1) x 30(mW)

R_L dissipation = $(V_{DD}-V_{EE})^2$ /50 x (number of segments + 1)(mW)

LED driver dissipation = number of LEDs x 20(mW)

Dynamic power consumption = V_{DD} x 5(mW)

Example

Where V_{EE} = -25V, V_{DD} = 5V, and in 16-segment and 6-digit modes,

FIP driver dissipation = 16 x 6 +6/7 x 30 = 122

R_L dissipation = 30^2 /50 x 17 = 306

LED driver dissipation = 4 x 20 = 80

Dynamic power consumption = 5 x 5 = 25

Total 553 Mw

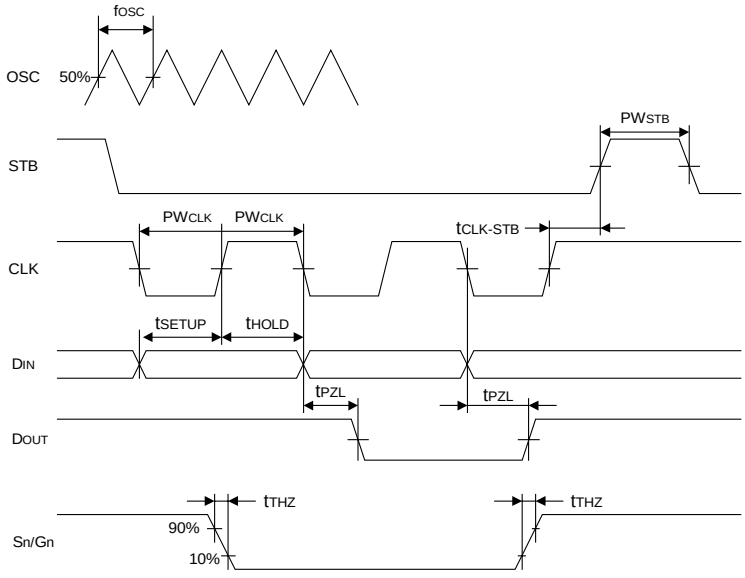
ELECTRICAL CHARACTERISTICS (Ta=-20 ~ 70 °C, V_{DD} =4.5 ~ 5.5V, V_{EE}=-30V)

Parameter	Symbol	Test conditions	Min	Typ	Max	Unit
High-Level Output Voltage	V_{OH1}	LED_1- LED_4, I_{OH1}=-1mA	0.9V_{DD}	--	--	V
Low -Level Output Voltage	V_{OL1}	LED_1- LED_4, I_{OL1} =20mA	--	--	1	V
Low -Level Output Voltage	V_{OL2}	D_{OUT}, I_{OL2}=4mA	--	--	0.4	V
High-Level Output Current	I_{OH21}	V_O=V_{DD}-2V, Seg_1 to Seg_{11}	-3	--	--	mA
High-Level Output Current	I_{OH22}	V_O=V_{DD}-2V, $Grid_1$ to $Grid_6$ Seg_{12}/$Grid_{11}$ to Seg_{16}/$Grid_7$	-15	--	--	mA
Driver Leakage Current	I_{OLEAK}	V_O= V_{DD} -35V,driver off	--	--	-10	μA
Output Pull-Down Resistor	R_L	Driver output	50	100	150	kΩ
Input Current	I_I	V_I=V_{DD} or V_{SS}	--	--	±1	μA
High-Level Input Voltage	V_{IH}	--	0.7V_{DD}	--	--	V
Low-Level Input Voltage	V_{IL}	--	--	--	0.3V_{DD}	V
Hysteresis voltage	V_H	CLK, D_{IN}, STB	--	0.35	--	V
Dynamic Current Consumption	I_{DDdyn}	Under no load, display off	--	--	5	mA

SWITCHING CHARACTERISTICS(Ta=-20 ~ 70 °C, V_{DD} =4.5 ~ 5.5V, V_{EE}=-30V)

Parameter	Symbol	Test conditions		Min	Typ	Max	Unit
Oscillation Frequency	t_{OSC}	R=51Ω		350	500	650	kHz
Propagation Delay Time	t_{PLZ}	CLK→ D_{OUT}		--	--	300	ns
	t_{PZL}	C_L=15pF, R_L=10kΩ		--	--	100	ns
Rise Time	t_{TZH1}	C_L=300pF	Seg_1 to Seg_{11}	--	--	2	μs
	t_{TZH2}		$Grid_1$ to Grid6, $Seg_{12}/Grid_{11}$ to $Seg_{16}/Grid_7$	--	--	0.5	μs
Fall Time	t_{THZ}	C_L=300pF, Segn, Gridn		--	--	120	μs
Maximum Clock Frequency	fmax.	Duty=50%		1	--	--	MHz
Input Capacitance	C_I	--		--	--	15	pF

SWITCHING CHARACTERISTIC WAVEFORMS



TIMING CONDITIONS(Ta=-20 ~ 70 °C, V_{DD} =4.5 ~ 5.5V)

Parameter	Symbol	Test conditions	Min	Typ	Max	Unit
Clock Pulse Width	PW_{CLK}	--	400	--	--	ns
Strobe Pulse Width	PW_{STB}	--	1	--	--	μs
Data Setup Time	t_{SETUP}	--	100	--	--	ns
Data Hold Time	t_{HOLD}	--	100	--	--	ns
Clock-Strobe Time	$t_{CLK-STB}$	CLK ↑ → STB ↑	1	--	--	μs
Wait Time	t_{WAT}	CLK ↑ → CLK ↓ Note	1	--	--	μs

Note: When data is read, a wait time t_{WAIT} of 1 μs is necessary since the rising of the eighth clock that has set the command, until the falling of the first clock that has read the data.

PAD DESCRIPTION

Pin No.	Symbol	Pin Name	Description
6	D_{IN}	Data input	Input serial data at rising edge of shift clock, starting from the low order bit.
5	D_{OUT}	Data output	Output serial data at the falling edge of the shift clock, starting from low order bit. This is N-ch open-drain output pin.
9	STB	Strobe	Initializes serial interface at the rising or falling edge of the SC16312. It then waits for reception of a command. Data input after STB has fallen is processed as a command. While command data is processed, current processing is stopped, and the serial interface is initialized. While STB is high, CLK is ignored.
8	CLK	Clock input	Reads serial data at the rising edge, and outputs data at the falling edge.
44	OSC	Oscillator pin	Connect resistor to this pin to determine the oscillation frequency to this pin.
15 ~ 20	Seg_1/KS_1 to Seg_6/KS_6	High-voltage output	Segment output pins (Dual function as key source).
21 ~ 25	Seg_7 to Seg_{11}	High-voltage output (segment)	Segment output pins.
37 ~ 32	$Grid_1$ to $Grid_6$	High-voltage output (grid)	Grid output pins.

(to be continued)

(continued)

Pin No.	Symbol	Pin Name	Description
26,28 ~ 31	$Seg_{12}/Grid_{11}$ to $Seg1_6/Grid_7$	High-voltage output (segment/grid)	These pins are selectable for segment or grid driving.
42 ~ 39	LED_1 to LED_4	LED output	CMOS output. +20mA max.
10 ~ 13	KEY_1 to KEY_4	Key data input	Data input to these pins is latched at the end of the display cycle.
1 ~ 4	SW_1 to SW_4	Switch input	These pins constitute a 4-bit general-purpose input port.
14,38	V_{DD}	Logic power	5V±10%
7,43	V_{SS}	Logic ground	Connect this pin to system GND.
27	V_{EE}	Pull-down level	V_{DD}-35V max.

FUNCTIONAL DESCRIPTION

1. DISPLAY RAM ADDRESS AND DISPLAY MODE

The display RAM stores the data transmitted from an external device to the SC16312 through the serial interface, and is assigned addresses as follows, in 8 bits unit:

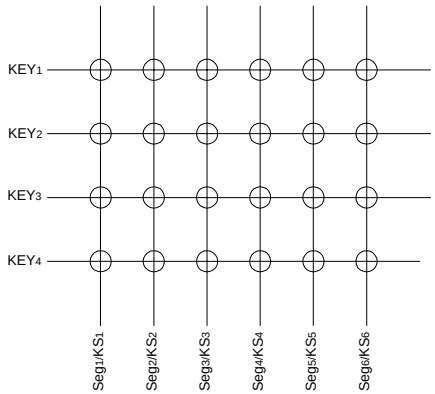
Seg_1	Seg_4	Seg_8	Seg_{12}	Seg_{16}	
$00H_L$	$00H_U$	$01H_L$	$01H_U$		DIG_1
$02H_L$	$02H_U$	$03H_L$	$03H_U$		DIG_2
$04H_L$	$04H_U$	$05H_L$	$05H_U$		DIG_3
$06H_L$	$06H_U$	$07H_L$	$07H_U$		DIG_4
$08H_L$	$08H_U$	$09H_L$	$09H_U$		DIG_5
$0AH_L$	$0AH_U$	$0BH_L$	$0BH_U$		DIG_6
$0CH_L$	$0CH_U$	$0DH_L$	$0DH_U$		DIG_7
$0EH_L$	$0EH_U$	$0FH_L$	$0FH_U$		DIG_8
$10H_L$	$10H_U$	$11H_L$	$11H_U$		DIG_9
$12H_L$	$12H_U$	$13H_L$	$13H_U$		DIG_{10}
$14H_L$	$14H_U$	$15H_L$	$15H_U$		DIG_{11}

b_0	b_3	b_4	b_7
xxH_L		xxH_U	

Lower 4 bits Higher 4 bits

2. KEY MATRIX AND KEY-INPUT DATA STORAGE RAM

The key matrix is made up of a 6 x 4 matrix, as shown below.



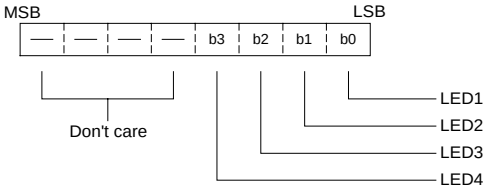
The data of each key is stored as illustrated below, and is read with the read command, starting from the least significant bit.

KEY1 ... KEY4	KEY1 ... KEY4
Seg1/KS1	Seg2/KS2
Seg3/KS3	Seg4/KS4
Seg5/KS5	Seg6/KS6
b0 --------- b3	b4 --------- b7

Reading sequence

3. LED PORT

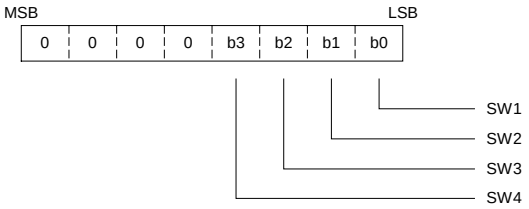
Data is written to the LED port with command, starting from the least port's least significant bit. When a bit of this port is 0, the corresponding LED lights; When the bit is 1, the LED turns off. The data of bits 5 through 8 are ignored.



On power application, all LEDs are unlit.

4. SW DATA

SW data is read with the read command, starting from the least significant bit. Bits 5 through 8 of the SW data are 0.



5. COMMANDS

Commands set the display mode and status of the FIP driver.

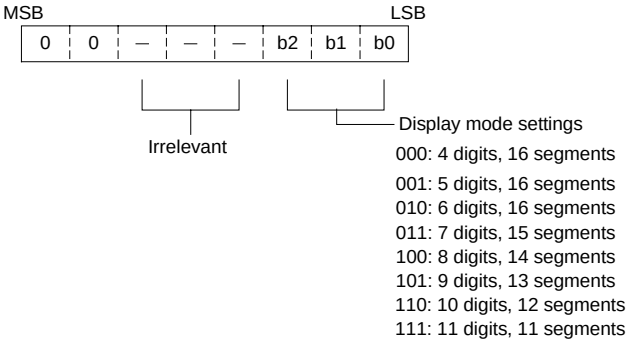
The first 1 byte input to the SC16312 through the D_{IN} pin after the STB pin has fallen is regarded as a command.

If STB is set high while commands/data are transmitted, serial communication is initialized, and the commands/data being transmitted are invalid(however, the commands/data previously transmitted remain valid).

(1) Display mode setting commands

These commands initialize the SC16312 and select the number of segments and the number of grid(1/4 to 1/11 duty, 11 segments to 16 segments).

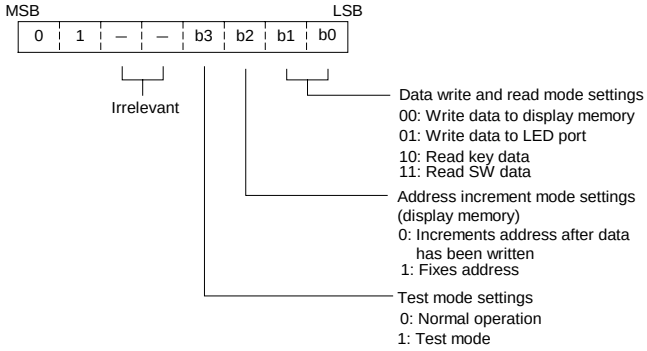
When these commands are executed, the display is forcibly turned off, and key scanning is also stopped. To resume display, the display command “ON” must be executed. If the same mode is selected, however, nothing happens.



On power application, the 11-digit, 11-segment mode is selected.

(2) Data setting commands

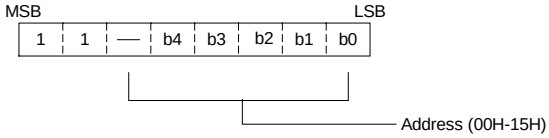
These commands set data write and data read modes.



On power application, the normal operation and address increment modes are set.

(3) Address setting commands

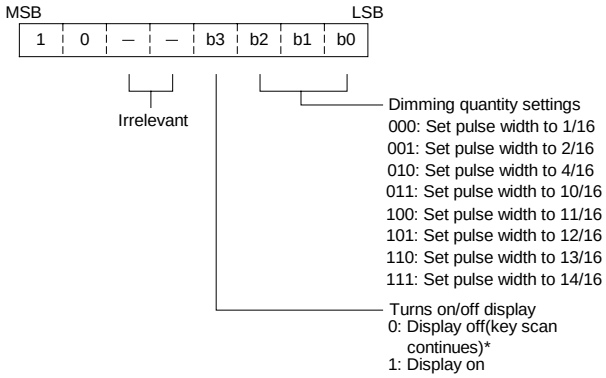
These commands set an address of the display memory.



If address 16H or higher is set, data is ignored, until a valid address is set.

On the power application, the address is set to 00H.

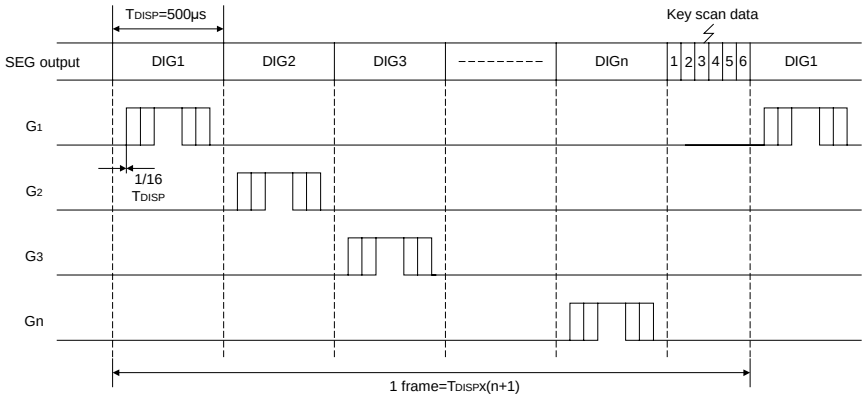
(4) Display control commands



On power application, the 1/6 pulse width is set and the display is turned off.

*Note: On power application, key scanning is stopped.

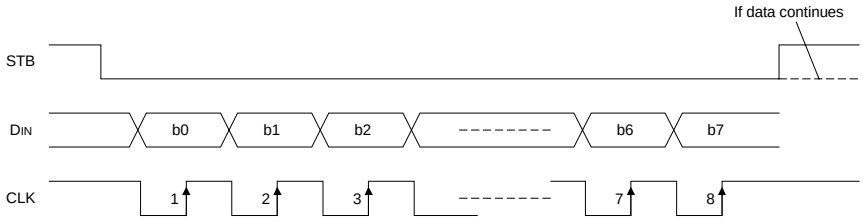
KEY SCANNING ANG DISPLAY TIMING



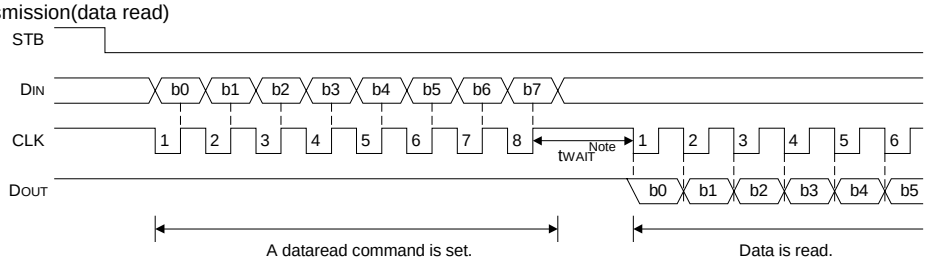
One cycle of key scanning consists of one frame, and data in a 6x4 matrix is stored in RAM.

SERIAL COMMUNICATION FORMAT

Reception(command/data write)



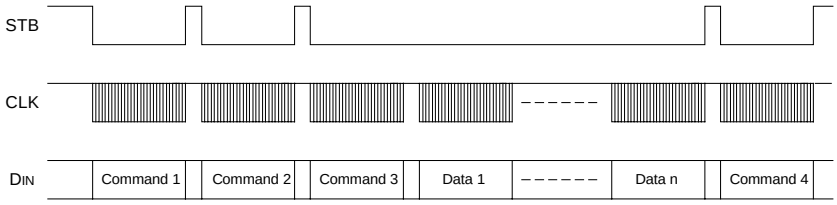
Transmission(data read)



Because the D_{OUT} pin is an N-ch, open-drain output pin, be sure to connect an external pull-up resistor to this pin(1kΩ to 10kΩ)..

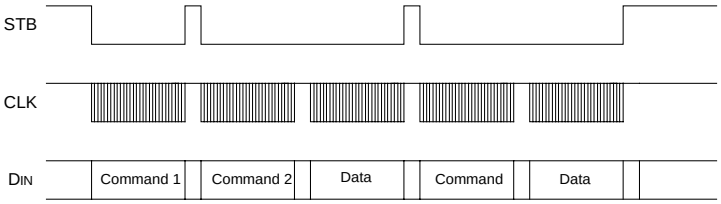
APPLICATION

Updating display memory by incrementing address



Command1: sets display mode
Command2: sets data
Command3: sets address
Data 1 to n: transfers display data(22 bytes max.)
Command4: controls display

Updating specific address



Command1: set data
Command2: sets address
Data: display data

PACKAGE OUTLINE

QFP-44-10x10-0.8 UNIT:mm