MPR121 GPIO and LED Driver Function

INTRODUCTION

MPR121 is a feature rich second generation touch sensor controller after Freescale's initial release of the MPR03x series device. MPR121 not only has priority unique features like independent electrode auto configuration (refer to AN3889), 13th simulated pseudo electrode for proximity detection (refer to AN3893), it also has 8 GPIO ports with LED driver capability. The GPIO and LED driver function can be used when not all the 12 input sensing channels are occupied for touch sensing detection, which is made possible by internal multiplexed pin structure. This increaseS the cost efficiency of the system and makes the MPR121 fit for even wider application.

MULTIFUNCTION PINS

MPR121 has 12 input sensing channels ELE0~ELE11, which occupies pin 8 to pin 19. Among these, pin 12 to pin 19 are multifunction pins. When these multifunction pins are not configured as electrodes, they may be used to drive LED or for general GPIO purpose.

PIN #	8	9	10	11	12	13	14	15	16	17	18	19
ELECTRODE	ELE0	ELE1	ELE2	ELE3	ELE4	ELE5	ELE6	ELE7	ELE8	ELE9	ELE10	ELE11
GPIO	—	—	—	—	GPIO0	GPIO1	GPIO2	GPIO3	GPIO4	GPIO5	GPIO6	GPIO7

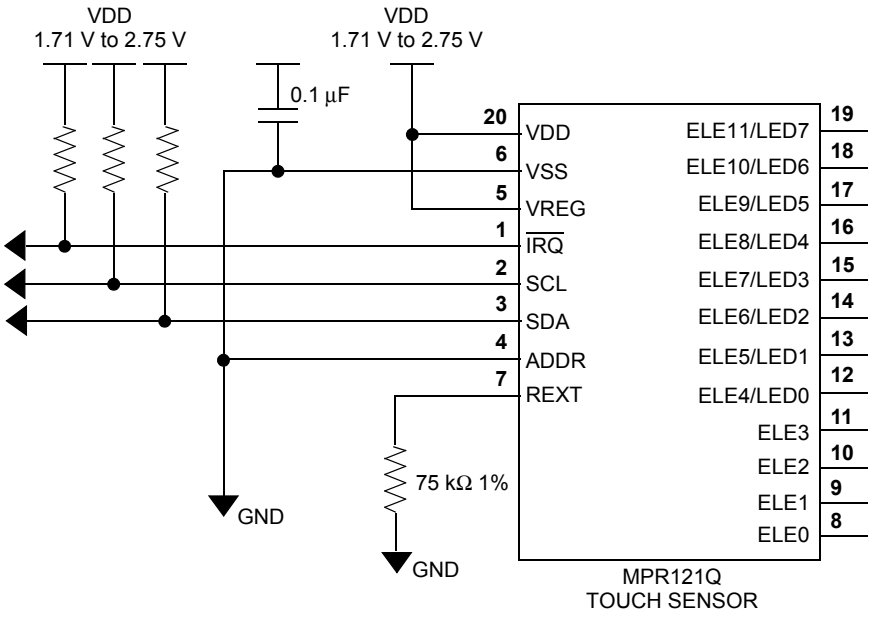

Figure 1. Configuration 1: MPR121 runs from a 1.71 V to 2.75 V supply.

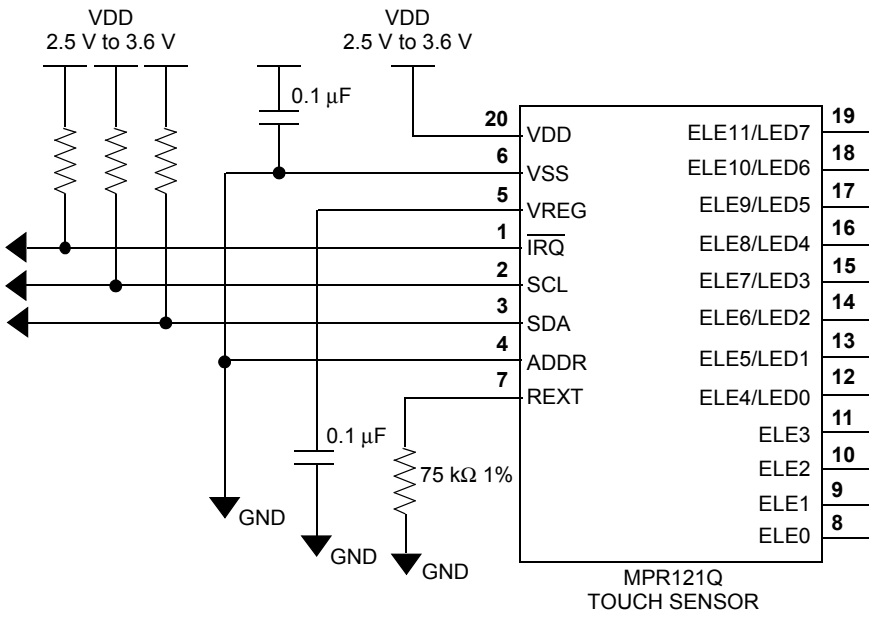

Figure 2. Configuration 2: MPR121 runs from a 2.5 V to 3.6 V supply.

These registers control GPIO function. D7~D0 bits corresponds GPIO7~GPIO0 pins respectively. The GPIO control registers can write always regardless Shutdown and Run mode.

Table 1. GPIO Control Registers

Name	Address	D7	D6	D5	D4	D3	D2	D1	D0
GPIO Control 0	**0x73**	CTL0[7]	CTL0[6]	CTL0[5]	CTL0[4]	CTL0[3]	CTL0[2]	CTL0[1]	CTL0[0]
GPIO Control 1	**0x74**	CTL1[7]	CTL1[6]	CTL1[5]	CTL1[4]	CTL1[3]	CTL1[2]	CTL1[1]	CTL1[0]
GPIO Data	**0x75**	DAT[7]	DAT[6]	DAT[5]	DAT[4]	DAT[3]	DAT[2]	DAT[1]	DAT[0]
GPIO Direction	**0x76**	DIR[7]	DIR[6]	DIR[5]	DIR[4]	DIR[3]	DIR[2]	DIR[1]	DIR[0]
GPIO Enable	**0x77**	EN[7]	EN[6]	EN[5]	EN[4]	EN[3]	EN[2]	EN[1]	EN[0]
GPIO Data Set	**0x78**	SET[7]	SET[6]	SET[5]	SET[4]	SET[3]	SET[2]	SET[1]	SET[0]
GPIO Data Clear	**0x79**	CLR[7]	CLR[6]	CLR[5]	CLR[4]	CLR[3]	CLR[2]	CLR[1]	CLR[0]
GPIO Data Toggle	**0x7A**	TOG[7]	TOG[6]	TOG[5]	TOG[4]	TOG[3]	TOG[2]	TOG[1]	TOG[0]

EN[7:0], DIR[7:0], CTL0[7:0], CTL1[7:0]: Configuration Register

The number of touch sensing electrodes (and therefore the number of GPIO ports available) is configured by the Electrode Configuration register (0x5E) and GPIO Enable Register (0x77), but electrode configuration has higher priority than GPIO feature. When a pin is enabled as GPIO but is also selected as electrode by Electrode Configuration Register, the GPIO function is disabled immediately and it becomes an electrode during Run mode. But all 8 ports automatically become GPIO ports in Shutdown mode because none of the ports are being enabled as touch electrodes in Shutdown mode.

During the shutdown mode just after power on reset, all 8 GPIO ports are in high impedance as all the GPIO ports are default disabled. Take care to program unused ports which are not going to be used as either touch electrodes or GPIO to avoid floating inputs or outputs shorted to a rail. One approach is to enable unused ports to be GPIO inputs with internal pull-up or pull-down.

The GPIO system allows the GPIO pins to be set as input or output. When an EN bit sets, the corresponding GPIO pin is enabled and the function is configured by CTL0, CTL1 and DIR bits. When the port is used as input, it can be configured as normal input or with additional internal pull-down or pull-up for input port. For output configuration, it can be push/pull or open drain.

EN	DIR	CTL[0:1]	DESCRIPTION
0	X	XX	GPIO function is disabled. Port is high-z state.
1	0	00	GPIO port becomes input port.
1	0	10	GPIO port becomes input port with internal pull-down.
1	0	11	GPIO port becomes input port with internal pull-up.
1	0	01	Not defined yet (as same as CTL = 00).
1	1	00	GPIO port becomes CMOS output port.
1	1	11	GPIO port becomes high side only open drain output port for LED driver.
1	1	10	GPIO port becomes low side only open drain output port.
1	1	01	Not defined yet (as same as CTL = 00).

DAT[7:0]: Data Register

When a GPIO is as output, the GPIO port outputs the bit level of this register. The output level toggle holds on any electrode charging and AD conversion and the level transition will be occurred after the AD conversion. Reading this register returns the content of the DAT register (not a level of the port).

When a GPIO is as input, reading this register returns latched input level of the corresponding port (not contents of the DAT register). A write changes content of the register, but not affect to the input function.

SET[7:0]: Set Data Register

Writing a “1” to bits in this register will set them in the Data Register.

CLR[7:0]: Clear Data Register

Writing a “1” to bits in this register will clear them in the Data Register.

TOG[7:0]: Toggle Data Register

Write a bit with “1” to the GPIO Data Set Register, GPIO Data Clear Register, and GPIO Toggle Register set/clear/toggle contents of the corresponding DAT bit. Write “0” has no meaning. Using of those registers allows any individual port(s) to be able individually set, cleared, or toggled without affecting other ports. Reading those register returns as same as DAT register reading.

LED DRIVER

Each GPIO pin has LED driver capability which can source up to 12 mA. When GPIO is used to driver LED, connect the GPIO output to an LED forward biased with its cathode to GND so that GPIO output high lights the LED. Place a current limiting resistor is series with LED to limit the current below 12 mA (refer to the typical application circuit).

When LED dimming control is needed, the PWM control register can be set to get the desired dimming control. Alternatively, the PWM can also be used to drive the beeper.

Table 2. PWM_[3:0}: PWM Duty Control Registers

Name	Address	D7	D6	D5	D4	D3	D2	D1	D0
PWM 0	**0x81**	PWM1[3]	PWM1[2]	PWM1[1]	PWM1[0]	PWM0[3]	PWM0[2]	PWM0[1]	PWM0[0]
PWM 1	**0x82**	PWM3[3]	PWM3[2]	PWM3[1]	PWM3[0]	PWM2[3]	PWM2[2]	PWM2[1]	PWM2[0]
PWM 2	**0x83**	PWM5[3]	PWM5[2]	PWM5[1]	PWM5[0]	PWM4[3]	PWM4[2]	PWM4[1]	PWM4[0]
PWM 3	**0x84**	PWM7[3]	PWM7[2]	PWM7[1]	PWM7[0]	PWM6[3]	PWM6[2]	PWM6[1]	PWM6[0]

PWM0[3:0] ~ PWM7[3:0] is used to set the PWM duty of GPIO0 ~ GPIO7 respectively. The power up reset default setting for these four register is 0x00. When a GPIO is programmed as output and the DAT register is “1” and if the corresponding PWM_ [3:0] register is not zero, the GPIO pin outputs PWM waveform. The PWM period is fixed 8ms (1/256 of 32 KHz OSC) and PWM_ [3:0] register decides duty of the waveform.

PWM_ [3:0]	Description (_ is 0~7)
0	PWM is off, GPIO outputs stable high when DAT register is “1”
1	GPIO output duty is 1:15 (mostly output low)
2	GPIO output duty is 2:14 (mostly output low)
—	—
15	GPIO output duty is 15:1 (mostly output high)

These register can be read/write any time, even if MPR121 is in Run Mode. When the register changes during PWM enables, a mixed duty cycle would be possible to occur.

The PWM duty is not so much accurate, because GPIO output transition (include PWM) inhibits during measurement state. Therefore, when interval time (=Touch Detection Sample Interval) is close to measurement time (depends on charge time, AFE Samples and number of measurement electrodes), the PWM operation is disturbed and the waveform couldn’t keep programmed duty.

How to Reach Us:

Home Page:
www.freescale.com

Web Support:
http://www.freescale.com/support

USA/Europe or Locations Not Listed:
Freescale Semiconductor, Inc.
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
+1-800-521-6274 or +1-480-768-2130
www.freescale.com/support

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
+800 2666 8080
support.asia@freescale.com

For Literature Requests Only:
Freescale Semiconductor Literature Distribution Center
1-800-441-2447 or 303-675-2140
Fax: 303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com

AN3894
Rev. 0
03/2010