Analog Devices Inc./Maxim Integrated - MAXQ612G-0000+ Datasheet

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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	MAXQ20S
Core Size	16-Bit
Speed	12MHz
Connectivity	I²C, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, Infrared, Power-Fail, POR, WDT
Number of I/O	44
Program Memory Size	128KB (128K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	6K x 8
Voltage - Supply (Vcc/Vdd)	1.7V ~ 3.6V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Surface Mount
Package / Case	64-LQFP
Supplier Device Package	64-LQFP (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/analog-devices/maxq612g-0000

16-Bit Microcontrollers with Infrared Module and Optional USB

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ABSOLUTE MAXIMUM RATINGS

Voltage Range on V_{DD} with Respect to GND .....-0.3V to +3.6V
Voltage Range on Any Lead with
Respect to GND Except V_{BUS}..... -0.3V to (V_{DD} + 0.5V)
Voltage Range on V_{BUS} with Respect to GND....-0.3V to +6.0V
Continuous Output Current
Any Single I/O Pin.....25mA
All I/O Pins Combined.....25mA
Voltage Range on DP, DM with
Respect to GND.....-0.3V to (V_{BUS} + 0.3V)
Operating Temperature Range..... 0°C to +70°C
Storage Temperature Range..... -65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C
Soldering Temperature (reflow) .....+260°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

(V_{DD} = V_{RST} to 3.6V, T_A = 0°C to +70°C.) (Note 1)

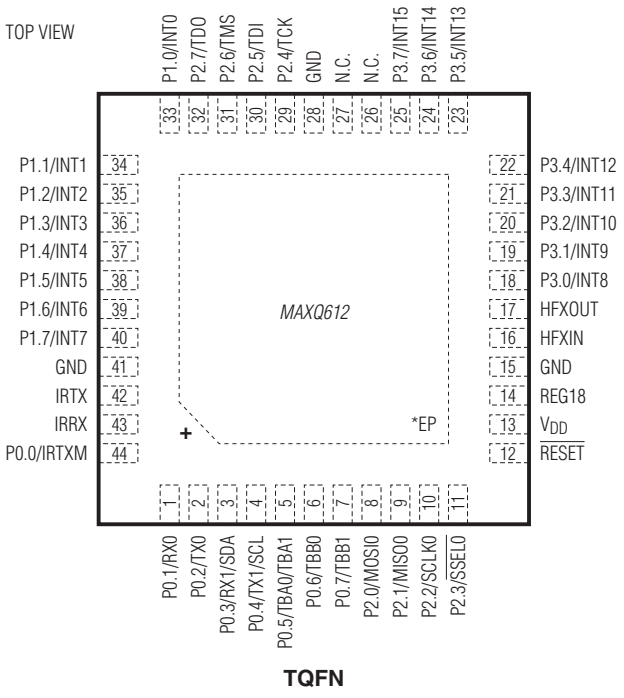
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage	V_{DD}			V_{RST}		3.6	V
1.8V Internal Regulator	V_{REG18}			1.62	1.8	1.98	V
Power-Fail Warning Voltage for Supply	V_{PFW}	Monitors V_{DD} (Notes 2, 3, 4)		1.75	1.8	1.85	V
Power-Fail Reset Voltage	V_{RST}	Monitors V_{DD} (Note 5)		1.64	1.67	1.70	V
POR Voltage	V_{POR}	Monitors V_{DD}		1.0		1.42	V
RAM Data-Retention Voltage	V_{DRV}	(Note 6)		1.0			V
Active Current	I_{DD_1}	Sysclk = 12MHz			4.8	5.5	mA
	I_{DD_2}	Sysclk = 1MHz (Note 6)			0.52	0.8	
Stop-Mode Current	I_{S1}	Power-Fail Off (Note 7)	T_A = +25°C		0.3	3	µA
			T_A = +70°C		2.8	13	
	I_{S2}	Power-Fail On	T_A = +25°C		24	30	
			T_A = +70°C		30	40	
Current Consumption During Power Fail	I_{PFR}	(Notes 6, 8, 9)		[(3 x I_{S2}) + ((PCI - 3) x (I_{S1} + I_{NANO}))]/ PCI			µA
Current Consumption During POR	I_{POR}	(Note 10)			100		nA
Stop-Mode Resume Time	t_{ON}				375 + 8192 t_{HFXIN}		µs
Power-Fail Monitor Startup Time	t_{PFM_ON}	(Note 6)				150	µs
Power-Fail Warning Detection Time	t_{PFW}	(Notes 6, 11)		10			µs
Input Low Voltage for IRTX, IRRX, $\overline{RESET}$, and All Port Pins	V_{IL}			V_{GND}		0.3 x V_{DD}	V
Input High Voltage for IRTX, IRRX, $\overline{RESET}$, and All Port Pins	V_{IH}			0.7 x V_{DD}		V_{DD}	V

RECOMMENDED OPERATING CONDITIONS (continued)

(V_{DD} = V_{RST} to 3.6V, T_A = 0°C to +70°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Single-Ended Receiver Threshold	V_{SE}		0.8		2.0	V
Single-Ended Receiver Hysteresis	V_{SEH}			200		mV
Differential Output Signal Cross-Point Voltage	V_{CRS}	C_L = 50pF (Note 6)	1.3		2.0	V
DP, DM Off-State Input Impedance	R_{LZ}		300			kΩ
Driver Output Impedance	R_{DRV}	Steady-state drive	28		44	Ω
DP Pullup Resistor	R_{PU}	Idle	0.9		1.575	kΩ
		Receiving	1.425		3.090	
USB TIMING						
DP, DM Rise Time (Transmit)	t_R	C_L = 50pF	4		20	ns
DP, DM Fall Time (Transmit)	t_F	C_L = 50pF	4		20	ns
Rise/Fall Time Matching (Transmit)	t_R/t_F	C_L = 50pF (Note 6)	90		110	%
IR						
Carrier Frequency	f_{IR}				$f_{CK}/2$	Hz
SPI (Note 6)						
SPI Master Operating Frequency	$1/t_{MCK}$				$f_{CK}/2$	MHz
SPI Slave Operating Frequency	$1/t_{SCK}$				$f_{CK}/4$	MHz
SPI I/O Rise/Fall Time	t_{SPI_RF}	C_L = 15pF, pullup = 560Ω	8		24	ns
SCLK_ Output Pulse-Width High/Low	t_{MCH}, t_{MCL}		$t_{MCK}/2$ - t_{SPI_RF}			ns
MOSI_ Output Hold Time After SCLK_ Sample Edge	t_{MOH}		$t_{MCK}/2$ - t_{SPI_RF}			ns
MOSI_ Output Valid to Sample Edge	t_{MOV}		$t_{MCK}/2$ - t_{SPI_RF}			ns
MISO_ Input Valid to SCLK_ Sample Edge Rise/Fall Setup	t_{MIS}		25			ns
MISO_ Input to SCLK_ Sample Edge Rise/Fall Hold	t_{MIH}		0			ns
SCLK_ Inactive to MOSI_ Inactive	t_{MLH}		$t_{MCK}/2$ - t_{SPI_RF}			ns
SCLK_ Input Pulse-Width High/Low	t_{SCH}, t_{SCL}			$t_{SCK}/2$		ns
$\overline{SSEL}$_ Active to First Shift Edge	t_{SSE}		t_{SPI_RF}			ns

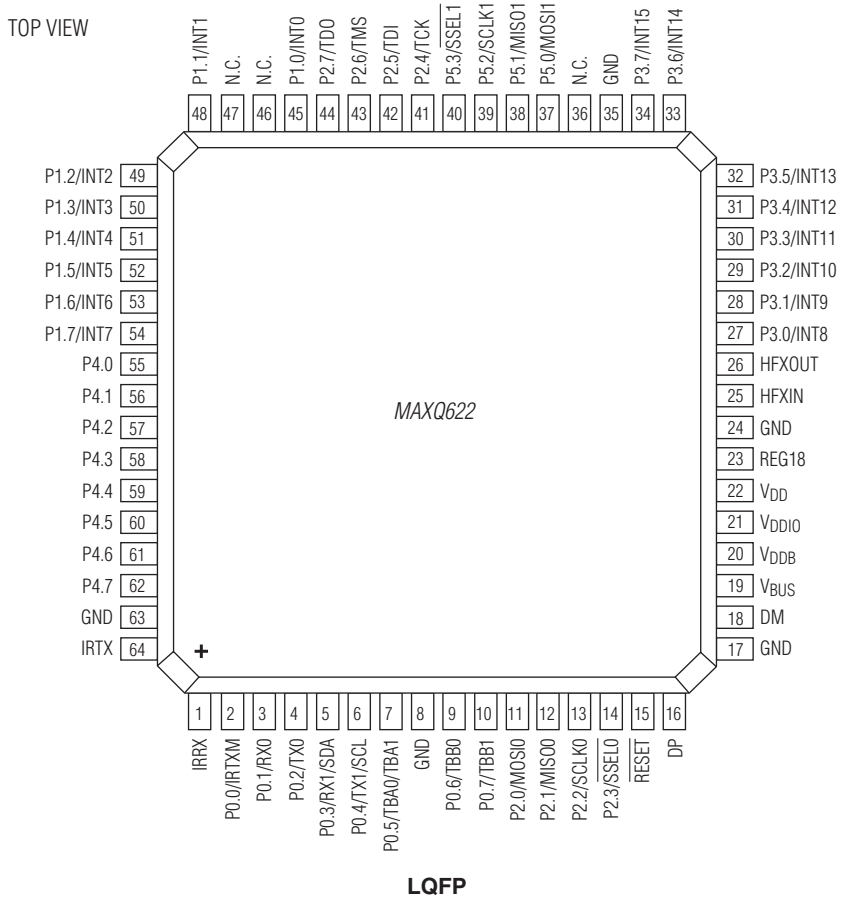
Pin Configurations



TQFN

*EXPOSED PAD.

Pin Configurations (continued)



LQFP

Pin Descriptions—TQFN, LQFP

PIN			NAME	FUNCTION
MAXQ612 TQFN-EP	MAXQ612 LQFP	MAXQ622 LQFP		
POWER PINS				
13	22	22	V_{DD}	Supply Voltage
15, 28, 41	8, 24, 35, 63	8, 17, 24, 35, 63	GND	Ground
14	23	23	REG18	Regulator Capacitor. This pin must be connected to ground through a 1.0µF external ceramic-chip capacitor. The capacitor must be placed as close to this pin as possible. No external devices other than the capacitor should be connected to this pin.

Pin Descriptions—TQFN, LQFP (continued)

<table>
<tr><th colspan="3">PIN</th><th rowspan="2">NAME</th><th rowspan="2">FUNCTION</th></tr>
<tr><th>MAXQ612 TQFN-EP</th><th>MAXQ612 LQFP</th><th>MAXQ622 LQFP</th></tr>
<tr><td colspan="6">GENERAL-PURPOSE I/O AND SPECIAL FUNCTION PINS</td></tr>
<tr><td rowspan="9">44, 1–7</td><td rowspan="9">2–7, 9, 10</td><td rowspan="9">2–7, 9, 10</td><td rowspan="9">P0.0–P0.7; IRTXM, RX0, TX0, RX1, TX1, SDA, SCL, TBA0, TBA1, TBB0, TBB1</td><td>General-Purpose, Digital, I/O, Type C Port. These port pins function as bidirectional I/O pins. All port pins default to three-state mode after a reset. All alternate functions must be enabled from software.
MAXQ612 TQFN-EP | MAXQ612 LQFP | MAXQ622 LQFP | PORT | SPECIAL FUNCTION
44 | 2 | 2 | P0.0 | IRTXM
1 | 3 | 3 | P0.1 | RX0
2 | 4 | 4 | P0.2 | TX0
3 | 5 | 5 | P0.3 | RX1/SDA
4 | 6 | 6 | P0.4 | TX1/SCL
5 | 7 | 7 | P0.5 | TBA0/TBA1
6 | 9 | 9 | P0.6 | TBB0
7 | 10 | 10 | P0.7 | TBB1</td></tr>
<tr><td rowspan="9">33–40</td><td rowspan="9">45, 48–54</td><td rowspan="9">45, 48–54</td><td rowspan="9">P1.0–P1.7; INT0–INT7</td><td>General-Purpose, Digital, I/O, Type D Port; External Edge-Selectable Interrupt. These port pins function as bidirectional I/O pins or as interrupts. All port pins default to three-state mode after a reset. All interrupt functions must be enabled from software.
MAXQ612 TQFN-EP | MAXQ612 LQFP | MAXQ622 LQFP | PORT | SPECIAL FUNCTION
33 | 45 | 45 | P1.0 | INT0
34 | 48 | 48 | P1.1 | INT1
35 | 49 | 49 | P1.2 | INT2
36 | 50 | 50 | P1.3 | INT3
37 | 51 | 51 | P1.4 | INT4
38 | 52 | 52 | P1.5 | INT5
39 | 53 | 53 | P1.6 | INT6
40 | 54 | 54 | P1.7 | INT7</td></tr>
</table>

Pin Descriptions—TQFN, LQFP (continued)

<table>
<tr><th colspan="3">PIN</th><th rowspan="2">NAME</th><th rowspan="2">FUNCTION</th></tr>
<tr><th>MAXQ612 TQFN-EP</th><th>MAXQ612 LQFP</th><th>MAXQ622 LQFP</th></tr>
<tr><td rowspan="11">8–11, 29–32</td><td rowspan="11">11–14, 41–44</td><td rowspan="11">11–14, 41–44</td><td rowspan="11">P2.0–P2.7; MOSI0, MISO0, SCLK0, $\overline{SSEL0}$, TCK, TDI, TMS, TDO</td><td>General-Purpose, Digital, I/O, Type C Port. These port pins function as bidirectional I/O pins. P2.0 to P2.3 default to three-state mode after a reset. All alternate functions must be enabled from software. Enabling the pin's special function disables the general-purpose I/O on the pin. The JTAG pins (P2.4 to P2.7) default to their JTAG function with weak pullups enabled after a reset. The JTAG function can be disabled using the TAP bit in the SC register.
P2.7 functions as the JTAG test-data output on reset and defaults to an input with a weak pullup. The output function of the test data is only enabled during the TAP's shift_IR or shift_DR states.</td></tr>
<tr><td><table>
<tr><th>MAXQ612 TQFN-EP</th><th>MAXQ612 LQFP</th><th>MAXQ622 LQFP</th><th>PORT</th><th>SPECIAL FUNCTION</th></tr>
<tr><td>8</td><td>11</td><td>11</td><td>P2.0</td><td>MOSI0</td></tr>
<tr><td>9</td><td>12</td><td>12</td><td>P2.1</td><td>MISO0</td></tr>
<tr><td>10</td><td>13</td><td>13</td><td>P2.2</td><td>SCLK0</td></tr>
<tr><td>11</td><td>14</td><td>14</td><td>P2.3</td><td>$\overline{SSEL0}$</td></tr>
<tr><td>29</td><td>41</td><td>41</td><td>P2.4</td><td>TCK</td></tr>
<tr><td>30</td><td>42</td><td>42</td><td>P2.5</td><td>TDI</td></tr>
<tr><td>31</td><td>43</td><td>43</td><td>P2.6</td><td>TMS</td></tr>
<tr><td>32</td><td>44</td><td>44</td><td>P2.7</td><td>TDO</td></tr>
</table></td></tr>
<tr><td rowspan="11">18–25</td><td rowspan="11">27–34</td><td rowspan="11">27–34</td><td rowspan="11">P3.0–P3.7; INT8–INT15</td><td>General-Purpose, Digital, I/O, Type D Port; External Edge-Selectable Interrupt. These port pins function as bidirectional I/O pins or as interrupts. All port pins default to three-state mode after a reset. All interrupt functions must be enabled from software.</td></tr>
<tr><td><table>
<tr><th>MAXQ612 TQFN</th><th>MAXQ612 LQFP</th><th>MAXQ622 LQFP</th><th>PORT</th><th>SPECIAL FUNCTION</th></tr>
<tr><td>18</td><td>27</td><td>27</td><td>P3.0</td><td>INT8</td></tr>
<tr><td>19</td><td>28</td><td>28</td><td>P3.1</td><td>INT9</td></tr>
<tr><td>20</td><td>29</td><td>29</td><td>P3.2</td><td>INT10</td></tr>
<tr><td>21</td><td>30</td><td>30</td><td>P3.3</td><td>INT11</td></tr>
<tr><td>22</td><td>31</td><td>31</td><td>P3.4</td><td>INT12</td></tr>
<tr><td>23</td><td>32</td><td>32</td><td>P3.5</td><td>INT13</td></tr>
<tr><td>24</td><td>33</td><td>33</td><td>P3.6</td><td>INT14</td></tr>
<tr><td>25</td><td>34</td><td>34</td><td>P3.7</td><td>INT15</td></tr>
</table></td></tr>
</table>

Pin Descriptions—TQFN, LQFP (continued)

<table>
<tr><th colspan="3">PIN</th><th rowspan="2">NAME</th><th rowspan="2">FUNCTION</th></tr>
<tr><th>MAXQ612 TQFN-EP</th><th>MAXQ612 LQFP</th><th>MAXQ622 LQFP</th></tr>
<tr><td rowspan="10">—</td><td rowspan="10">55-62</td><td rowspan="10">55–62</td><td rowspan="10">P4.0–P4.7</td><td>General-Purpose, Digital, I/O, Type C Port. These port pins function as bidirectional I/O pins. All port pins default to three-state mode after a reset.</td></tr>
<tr><td><table>
<tr><th>MAXQ612 TQFN-EP</th><th>MAXQ612 LQFP</th><th>MAXQ622 LQFP</th><th>PORT</th><th>SPECIAL FUNCTION</th></tr>
<tr><td>—</td><td>55</td><td>55</td><td>P4.0</td><td>—</td></tr>
<tr><td>—</td><td>56</td><td>56</td><td>P4.1</td><td>—</td></tr>
<tr><td>—</td><td>57</td><td>57</td><td>P4.2</td><td>—</td></tr>
<tr><td>—</td><td>58</td><td>58</td><td>P4.3</td><td>—</td></tr>
<tr><td>—</td><td>59</td><td>59</td><td>P4.4</td><td>—</td></tr>
<tr><td>—</td><td>60</td><td>60</td><td>P4.5</td><td>—</td></tr>
<tr><td>—</td><td>61</td><td>61</td><td>P4.6</td><td>—</td></tr>
<tr><td>—</td><td>62</td><td>62</td><td>P4.7</td><td>—</td></tr>
</table></td></tr>
<tr><td rowspan="6">—</td><td rowspan="6">37–40</td><td rowspan="6">37–40</td><td rowspan="6">P5.0–P5.3; MOSI1, MISO1, SCLK1, $\overline{\text{SSEL1}}$</td><td>General-Purpose, Digital, I/O, Type C Port. These port pins function as bidirectional I/O pins. All port pins default to three-state mode after a reset. All alternate functions must be enabled from software. Enabling the pin's special function disables the general-purpose I/O on the pin.</td></tr>
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<tr><th>MAXQ612 TQFN-EP</th><th>MAXQ612 LQFP</th><th>MAXQ622 LQFP</th><th>PORT</th><th>SPECIAL FUNCTION</th></tr>
<tr><td>—</td><td>37</td><td>37</td><td>P5.0</td><td>MOSI1</td></tr>
<tr><td>—</td><td>38</td><td>38</td><td>P5.1</td><td>MISO1</td></tr>
<tr><td>—</td><td>39</td><td>39</td><td>P5.2</td><td>SCLK1</td></tr>
<tr><td>—</td><td>40</td><td>40</td><td>P5.3</td><td>$\overline{\text{SSEL1}}$</td></tr>
</table></td></tr>
<tr><td colspan="5">NO CONNECTION PINS</td></tr>
<tr><td>26, 27</td><td>16–21, 36, 46, 47</td><td>36, 46, 47</td><td>N.C.</td><td>No Connection. Reserved for future use. Leave these pins unconnected.</td></tr>
<tr><td colspan="5">EXPOSED PAD</td></tr>
<tr><td>—</td><td>—</td><td>—</td><td>EP</td><td>Exposed Pad (TQFN Only). Connect EP to the ground plane.</td></tr>
</table>

Pin Descriptions—Bare Die (continued)

<table>
<tr><th colspan="2">PIN</th><th rowspan="2">NAME</th><th rowspan="2">FUNCTION</th></tr>
<tr><th>MAXQ612</th><th>MAXQ622</th></tr>
<tr><td colspan="4">IR FUNCTION PINS</td></tr>
<tr><td>74</td><td>74</td><td>IRTX</td><td>IR Transmit Output. Active-low IR transmit pin capable of sinking 25mA. This pin defaults to three-state input with the weak pullup disabled during all forms of reset. Software must configure this pin after release from reset to remove the three-state input condition.</td></tr>
<tr><td>75</td><td>75</td><td>IRRX</td><td>IR Receive Input</td></tr>
<tr><td colspan="4">GENERAL-PURPOSE I/O AND SPECIAL FUNCTION PINS</td></tr>
<tr><td rowspan="10">1, 2, 3, 5, 6, 7, 9, 10</td><td rowspan="10">1, 2, 3, 5, 6, 7, 9, 10</td><td rowspan="10">P0.0–P0.7; IRTXM, RX0, TX0, RX1, TX1, SDA, SCL, TBA0, TBA1, TBB0, TBB1</td><td>General-Purpose, Digital, I/O, Type C Port. These port pins function as bidirectional I/O pins. All port pins default to three-state mode after a reset. All alternate functions must be enabled from software.</td></tr>
<tr><td>
<table>
<tr><th>MAXQ612</th><th>MAXQ622</th><th>PORT</th><th>SPECIAL FUNCTION</th></tr>
<tr><td>1</td><td>1</td><td>P0.0</td><td>IRTXM</td></tr>
<tr><td>2</td><td>2</td><td>P0.1</td><td>RX0</td></tr>
<tr><td>3</td><td>3</td><td>P0.2</td><td>TX0</td></tr>
<tr><td>5</td><td>5</td><td>P0.3</td><td>RX1/SDA</td></tr>
<tr><td>6</td><td>6</td><td>P0.4</td><td>TX1/SCL</td></tr>
<tr><td>7</td><td>7</td><td>P0.5</td><td>TBA0/TBA1</td></tr>
<tr><td>9</td><td>9</td><td>P0.6</td><td>TBB0</td></tr>
<tr><td>10</td><td>10</td><td>P0.7</td><td>TBB1</td></tr>
</table>
</td></tr>
<tr><td rowspan="10">55, 56, 58–63</td><td rowspan="10">55, 56, 58–63</td><td rowspan="10">P1.0–P1.7; INT0–INT7</td><td>General-Purpose, Digital, I/O, Type D Port; External Edge-Selectable Interrupt. These port pins function as bidirectional I/O pins or as interrupts. All port pins default to three-state mode after a reset. All interrupt functions must be enabled from software.</td></tr>
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<tr><th>MAXQ612</th><th>MAXQ622</th><th>PORT</th><th>SPECIAL FUNCTION</th></tr>
<tr><td>55</td><td>55</td><td>P1.0</td><td>INT0</td></tr>
<tr><td>56</td><td>56</td><td>P1.1</td><td>INT1</td></tr>
<tr><td>58</td><td>58</td><td>P1.2</td><td>INT2</td></tr>
<tr><td>59</td><td>59</td><td>P1.3</td><td>INT3</td></tr>
<tr><td>60</td><td>60</td><td>P1.4</td><td>INT4</td></tr>
<tr><td>61</td><td>61</td><td>P1.5</td><td>INT5</td></tr>
<tr><td>62</td><td>62</td><td>P1.6</td><td>INT6</td></tr>
<tr><td>63</td><td>63</td><td>P1.7</td><td>INT7</td></tr>
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Pin Descriptions—Bare Die (continued)

<table>
<tr><th colspan="2">PIN</th><th rowspan="2">NAME</th><th colspan="4">FUNCTION</th></tr>
<tr><th>MAXQ612</th><th>MAXQ622</th></tr>
<tr><td rowspan="6">46–49</td><td rowspan="6">46–49</td><td rowspan="6">P5.0–P5.3; MOSI1, MISO1, SCLK1, $\overline{\text{SSEL1}}$</td><td colspan="4">General-Purpose, Digital, I/O, Type C Port. These port pins function as bidirectional I/O pins. All port pins default to three-state mode after a reset. All alternate functions must be enabled from software. Enabling the pin's special function disables the general-purpose I/O on the pin.</td></tr>
<tr><td>MAXQ612</td><td>MAXQ622</td><td>PORT</td><td>SPECIAL FUNCTION</td></tr>
<tr><td>46</td><td>46</td><td>P5.0</td><td>MOSI1</td></tr>
<tr><td>47</td><td>47</td><td>P5.1</td><td>MISO1</td></tr>
<tr><td>48</td><td>48</td><td>P5.2</td><td>SCLK1</td></tr>
<tr><td>49</td><td>49</td><td>P5.3</td><td>$\overline{\text{SSEL1}}$</td></tr>
<tr><td rowspan="9">12–15, 38, 41, 43, 44</td><td rowspan="9">12–15, 41–44</td><td rowspan="9">P6.0–P6.7</td><td colspan="4">General-Purpose, Digital, I/O, Type C Port. These port pins function as bidirectional I/O pins. All port pins default to three-state mode after a reset.</td></tr>
<tr><td>MAXQ612</td><td>MAXQ622</td><td>PORT</td><td>SPECIAL FUNCTION</td></tr>
<tr><td>12</td><td>12</td><td>P6.0</td><td>—</td></tr>
<tr><td>13</td><td>13</td><td>P6.1</td><td>—</td></tr>
<tr><td>14</td><td>14</td><td>P6.2</td><td>—</td></tr>
<tr><td>15</td><td>15</td><td>P6.3</td><td>—</td></tr>
<tr><td>38</td><td>41</td><td>P6.4</td><td>—</td></tr>
<tr><td>41</td><td>42</td><td>P6.5</td><td>—</td></tr>
<tr><td>43</td><td>43</td><td>P6.6</td><td>—</td></tr>
<tr><td>44</td><td>44</td><td>P6.7</td><td>—</td></tr>
<tr><td colspan="6">NO CONNECTION PINS</td></tr>
<tr><td>4, 11, 17, 22–27, 52, 57, 64</td><td>4, 11, 17, 52, 57, 64</td><td>N.C.</td><td colspan="4">No Connection. Reserved for future use. Leave these pins unconnected.</td></tr>
</table>

Detailed Description

The MAXQ612/MAXQ622 provide integrated, low-cost solutions that simplify the design of IR communications equipment such as universal remote controls. Standard features include the highly optimized, single-cycle, MAXQ, 16-bit RISC core; 128KB of flash memory; 6KB data RAM; soft stack; 16 general-purpose registers; and three data pointers. The MAXQ core has the industry's best MIPS/mA rating, allowing developers to achieve the same performance as competing microcontrollers at substantially lower clock rates. Lower active-mode current combined with the even lower MAXQ612/MAXQ622 stop-mode current results in increased battery life. IR application-specific peripherals include flexible timers for generating IR carrier frequencies and modulation. A high-current, 25mA, IR drive pin and output pins capable of sinking up to 5mA support IR applications. It also includes a USB slave interface compatible with existing host HID device drivers, I^2C, dual SPI, dual USARTs, up to 56 general-purpose I/O pins ideal for keypad matrix input, and a power-fail-detection circuit to notify.

Operating from DC to 12MHz, almost all instructions execute in a single clock cycle (83.3ns at 12MHz), enabling nearly 12MIPS true-code operation. When active device operation is not required, an ultra-low-power stop mode can be invoked from software, resulting in quiescent current consumption of less than 300nA typical and 3µA maximum. The combination of high-performance instructions and ultra-low

stop-mode current increases battery life over competing microcontrollers. An integrated POR circuit with brownout support resets the device to a known condition following a power-up cycle or brownout condition. Additionally, a power-fail warning flag is set, and a power-fail interrupt can be generated when the system voltage falls below the power-fail warning voltage, V_{PFW}. The power-fail warning feature allows the application to notify the user that the system supply is low and appropriate action should be taken.

Microprocessor

The MAXQ612/MAXQ622 are based on Maxim's MAXQ20 core, which is a low-power implementation of the new 16-bit MAXQ family of RISC cores. The core supports the Harvard memory architecture with separate internal 16-bit program and data address buses. A fixed 16-bit instruction word is standard, but data can be arranged in 8 or 16 bits. The MAXQ core is a pipelined processor with performance approaching 1MIPS per MHz. The 16-bit data path is implemented around register modules, and each register module contributes specific functions to the core. The accumulator module consists of sixteen 16-bit registers and is tightly coupled with the arithmetic logic unit (ALU). Program flow is supported by a configurable soft stack.

Execution of instructions is triggered by data transfer between functional register modules or between a functional register module and memory. Because data movement involves only source and destination modules, circuit switching activities are limited to active modules only. For power-conscious applications, this approach localizes power dissipation and minimizes switching noise. The modular architecture also provides a maximum of flexibility and reusability that are important for a microprocessor used in embedded applications.

The MAXQ instruction set is highly orthogonal. All arithmetical and logical operations can use any register in conjunction with the accumulator. Data movement is supported from any register to any other register. Memory is accessed through specific data-pointer registers with autoincrement/decrement support.

Memory

The microcontroller incorporates several memory types:

- 128KB program flash memory
- 6KB SRAM data memory
- 6KB utility ROM
- Soft stack

Memory Protection

The optional memory-protection feature separates code memory into three areas: system, user loader, and user application. Code in the system area can be kept confidential. Code in the user areas can be prevented from reading and writing system code. The user loader can also be protected from user application code.

Memory protection is implemented using privilege levels for code. Each area has an associated privilege level. RAM/ROM are assigned privilege levels as well. Refer to the *MAXQ622 User's Guide* for a more thorough explanation of the topic.

Stack Memory

A 16-bit-wide internal stack provides storage for program return addresses and can also be used for general-purpose data storage. The stack is used automatically by the processor when the CALL, RET, and RETI instructions are executed and when an interrupt is serviced. An application can also store values in the stack explicitly by using the PUSH, POP, and POPI instructions.

On reset, the stack pointer, SP, initializes to the top of the stack (BF0h). The CALL, PUSH, and interrupt-vectoring operations decrement SP, then store a value at the location pointed to by SP. The RET, RETI, POP, and POPI operations retrieve the value at SP and then increment SP.

Utility ROM

The utility ROM is a 6KB block of internal ROM memory that defaults to a starting address of 8000h. The utility

Table 1. Memory Areas and Associated Maximum Privilege Levels

AREA	PAGE ADDRESS	MAXIMUM PRIVILEGE LEVEL
System	0 to ULDR-1	High
User Loader	ULDR to UAPP-1	Medium
User Application	UAPP to top	Low
Utility ROM	N/A	High
Other (RAM)	N/A	Low

2) Transfers its current IRV value to the IRMT.

3) Resets IRV content to 0000h (if IRXRL = 1).

4) Continues counting again until the next qualified event.

If the IR timer value rolls over from 0FFFFh to 0000h before a qualified event happens, the IR timer overflow (IROV) flag is set to 1 and an interrupt is generated, if enabled. The IR module continues to operate in receive mode until it is stopped by switching into transmit mode or clearing IREN = 0.

Carrier Burst-Count Mode

A special mode reduces the CPU processing burden when performing IR learning functions. Typically, when operating in an IR learning capacity, some number of carrier cycles are examined for frequency determination. Once the frequency has been determined, the IR receive function can be reduced to counting the number of carrier pulses in the burst and the duration of the combined mark-space time within the burst. To simplify this process, the receive burst-count mode can be used. When RXBCNT = 0, the standard IR receive capture functionality is in place. When RXBCNT = 1, the IRV capture operation is disabled and the interrupt flag associated with the capture no longer denotes a capture. In the carrier burst-count mode, the IRMT register only counts qualified edges. The IRIF interrupt flag now sets if two IRCA cycles elapse without getting a qualified edge. The IRIF interrupt flag thus denotes absence of the carrier and the beginning of a space in the receive signal. The IRCFME bit is still used to define whether the IRV register is counting system IRCLK clocks or IRCA-defined carrier cycles. The IRXRL bit defines whether the IRV register is reloaded with 0000h on detection of a qualified edge (per the IRXSEL[1:0] bits).

16-Bit Timers/Counters

The microcontroller provides two general-purpose timers/counters that support the following functions:

- 16-bit timer/counter
- 16-bit up/down autoreload
- Counter function of external pulse
- 16-bit timer with capture
- 16-bit timer with compare
- Input/output enhancements for pulse-width modulation
- Set/reset/toggle output state on comparator match
- Prescaler with 2n divider (for n = 0, 2, 4, 6, 8, 10)

General-Purpose I/O

The microcontroller provides port pins for general-purpose I/O that have the following features:

- CMOS output drivers
- Schmitt trigger inputs
- Optional weak pullup to V_{DD} when operating in input mode

While the microcontroller is in a reset state, all port pins become three-state with both weak pullups and input buffers disabled, unless otherwise noted.

From a software perspective, each port appears as a group of peripheral registers with unique addresses. Special function pins can also be used as general-purpose I/O pins when the special functions are disabled. For a detailed description of the special functions available for each pin, refer to the IC-specific user's guide, e.g., the *MAXQ622 User's Guide* describes all special functions available on the MAXQ612/MAXQ622.

Serial Peripherals

The microcontroller supports two independent USARTs, two SPI master/slave communications ports, and an I^2C bus.

USART

The USART units are implemented with the following characteristics:

- 2-wire interface
- Full-duplex operation for asynchronous data transfers
- Half-duplex operation for synchronous data transfers
- Programmable interrupt for receive and transmit
- Independent baud-rate generator

Table 3. USART Mode Details

MODE	TYPE	START BITS	DATA BITS	STOP BITS
Mode 0	Synchronous	N/A	8	N/A
Mode 1	Asynchronous	1	8	1
Mode 2	Asynchronous	1	8 + 1	1
Mode 3	Asynchronous	1	8 + 1	1

pin to GND. The clock source should be driven through a CMOS driver. If the clock driver is a TTL gate, its output must be connected to V_{DD} through a pullup resistor to ensure a satisfactory logic level for active clock pulses. To minimize system noise on the clock circuitry, the external clock source must meet the maximum rise and fall times and the minimum high and low times specified for the clock source. The external noise can affect the clock generation circuit if these parameters do not meet the specification.

Noise at HFXIN and HFXOUT can adversely affect on-chip clock timing. It is good design practice to place the crystal and capacitors as near the oscillator circuitry as possible with a direct short trace. The typical values of external capacitors vary with the type of crystal to be used.

ROM Loader

The ROM loader loads program memory and configures loader-specific configuration features. To increase the security of the system, the loader denies access to the system, user loader, or user-application memories unless an area-specific password is provided.

Loading Flash Memory

An internal bootstrap loader allows reloading over a simple JTAG interface. As a result, software can be upgraded in-system, eliminating the need for a costly hardware retrofit when updates are required. Remote software uploads are possible that enable physically inaccessible applications to be frequently updated. The interface hardware can be a JTAG connection to another microcontroller, or a connection to a PC serial port using a USB-to-JTAG converter such as the MAXQUSBJTAG-KIT#, available from Maxim. If in-system programmability is not required, a commercial gang programmer can be used for mass programming. Activating the JTAG interface and loading the test access port (TAP) with the system programming instruction invokes the bootstrap loader. Setting the SPE bit to one during reset through the JTAG interface executes the bootstrap-loader mode program that resides in the utility ROM. When programming is complete, the bootstrap loader can clear the SPE bit and reset the device, allowing the device to bypass the utility ROM and begin execution of the application software.

In addition, the ROM loader also enforces the memory-protection policies. Passwords that are 16 words are required to access the ROM loader interface.

_In-Application Flash Programming

From user-application code, flash memory can be programmed using the ROM utility functions from either C or assembly language. The function declarations below show examples of some of the ROM utility functions provided for in-application flash memory programming:

```
/* Write one 16-bit word to code address 'dest'.
* Dest must be aligned to 16 bits.
* Returns 0 = failure, 1 = OK.
*/
int flash_write (uint16_t dest, uint16_t data);
```

To erase, the following function would be used:

```
/* Erase the given Flash page
* addr: Flash offset (anywhere within page)
*/
int flash_erasepage(uint16_t addr);
```

The in-application flash memory programming must call ROM utility functions to erase and program any of the flash memory. Memory protection is enforced by the ROM utility functions.

In-Circuit Debug and JTAG Interface

Embedded debug hardware and software are developed and integrated to provide full in-circuit debugging capability in a user-application environment. These hardware and software features include the following:

- Debug engine
- Set of registers providing the ability to set breakpoints on register, code, or data using debug service routines stored in ROM

Collectively, these hardware and software features support two modes of in-circuit debug functionality:

- Background mode:

  CPU is executing the normal user program

  Allows the host to configure and set up the in-circuit debugger
- Debug mode:

  Debugger takes over the control of the CPU

  Read/write accesses to internal registers and memory

  Single-step of the CPU for trace operation

The interface to the debug engine is the TAP controller. The interface allows for communication with a bus

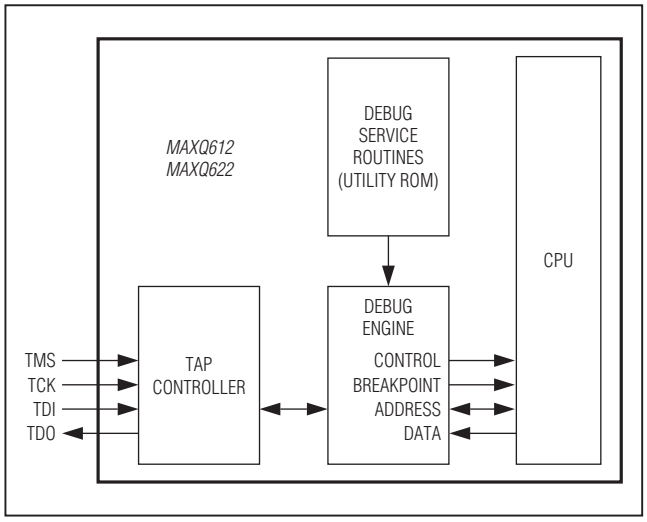


Figure 4. In-Circuit Debugger

master that can either be automatic test equipment or a component that interfaces to a higher level test bus as part of a complete system. The communication operates across a 4-wire serial interface from a dedicated TAP that is compatible with the JTAG IEEE Standard 1149. The TAP provides an independent serial channel to communicate synchronously with the host system.

To prevent unauthorized access of the protected memory regions through the JTAG interface, the debug engine prevents modification of the privilege registers and disallows all access to system memory, unless memory protection is disabled. In addition, all services (such as register display or modification) are denied when code is executing inside the system area.

Operating Modes

Power-Supply Selection

For maximum flexibility the microcontroller can be powered by either the USB (V_{BUS}) or V_{DD}. When a USB connection is made to a valid V_{BUS} power source, an internal voltage regulator generates a 3.3V supply voltage. When the internal voltage is at an adequate level, it automatically powers itself from the USB supply. This is especially beneficial in systems where the V_{DD} supply is from a battery. In either case, the chip is fully functional when operating from either the battery or the V_{BUS}.

The power monitor is attached to the switched supply, V_{DDIO}. This supply is equivalent to the higher of V_{DDB} or V_{DD}. This can be expressed as follows:

If (V_{DDB} > 3.0V or V_{DDB} > V_{DD})

then (V_{DDIO} = V_{DDB})

else (V_{DDIO} = V_{DD})

This means that if there is a power-fail event on V_{DD} and the device is not powered from V_{BUS}, it causes a power-fail interrupt (PFI) if enabled. If the device is powered by V_{BUS} and there is a supply on V_{DD}, then no power-fail event is triggered. If the device is powered by V_{BUS} and there is no supply on V_{DD} and V_{BUS} fails, the chip attempts to switch to V_{DD}, detects a power-fail event, and a PFI occurs. Some specific examples are given below:

- **Case 1: The device is powered from V_{DD} and the batteries are removed.** Power decays until the power-fail-reset trip point is hit, then the part goes into low-power mode.
- **Case 2: The device is set to be powered from V_{DD} only, it is connected to USB, and the batteries are removed.** Response is identical to Case 1.
- **Case 3: The device is set to be powered from either V_{DD} or V_{BUS}, it is connected to USB, and the batteries are removed.** Because the part is already powered from V_{BUS}, nothing changes. If the USB port is subsequently disconnected, power switches over to V_{DD}, the supply decays to the power-fail-reset trip point, and the part goes into low-power mode. As long as there is sufficient charge on the V_{DD} bypass capacitor, it supports the part in power-fail. The hold-up time is similar to the MAXQ610 since the USB port is powered only by V_{BUS}. Note that if the part is powered from V_{BUS} and no battery has been present for a long time (V_{DD} = 0), then upon USB port disconnection, the power collapses to ground in less than a second.

Stop Mode

The lowest power mode of operation is stop mode. In this mode, CPU state and memories are preserved, but the CPU is not actively running. Wake-up sources include external I/O interrupts, the power-fail warning interrupt, wake-up timer, or a power-fail reset. Any time the microcontroller is in a state where code does not need to be executed, the user software can put the microcontroller into stop mode. The nanopower ring oscillator is an internal ultra-low-power (400nA) 8kHz ring oscillator that can be used to drive a wake-up timer that exits stop mode. The wake-up timer is programmable by software in steps of 125µs up to approximately 8s.

The power-fail monitor is always on during normal operation. However, it can be selectively disabled during stop

Table 4. Power-Fail Warning Level Selection

PWCN.PFWARNCN[1:0]	PFW THRESHOLD (V)
00	1.8
01	1.9
10	2.55
11	2.75

mode to minimize power consumption. This feature is enabled using the power-fail monitor disable (PFD) bit in the PWCN register. The reset default state for the PFD bit is 1, which disables the power-fail monitor function during stop mode. If power-fail monitoring is disabled (PFD = 1) during stop mode, the circuitry responsible for generating a power-fail warning or reset is shut down and neither condition is detected. Thus, the $V_{DD} < V_{RST}$ condition does not invoke a reset state. However, in the event that V_{DD} falls below the POR level, a POR is generated. The power-fail monitor is enabled prior to stop mode exit and before code execution begins. If a power-fail warning condition ($V_{DD} < V_{PFW}$) is then detected, the power-fail interrupt flag is set on stop mode exit. If a power-fail reset condition is detected ($V_{DD} < V_{RST}$), the CPU goes into reset.

Power-Fail Warning

The power-fail monitor can assert an interrupt if the voltage falls below a configurable threshold between the operating voltage and the reset voltage. This, if enabled, can allow the firmware to perform housekeeping tasks if the voltage level decays below the warning threshold. The power-fail threshold value should only be changed when the power-fail warning interrupt is disabled (CKCN. PFIE = 0) to prevent unintended triggering of the power-fail warning condition.

The power-fail warning threshold is reset to 1.8V by a POR and is not affected by other resets. See Table 4.

Power-Fail Detection

Figures 5, 6, and 7 show the power-fail detection and response during normal and stop-mode operation.

If a reset is caused by a power-fail, the power-fail monitor can be set to one of the following intervals:

- Always on—continuous monitoring
- 2^{11} nanopower ring oscillator clocks (~256ms)
- 2^{12} nanopower ring oscillator clocks (~512ms)
- 2^{13} nanopower ring oscillator clocks (~1.024s)

In the case where the power-fail circuitry is periodically turned on, the power-fail detection is turned on for two

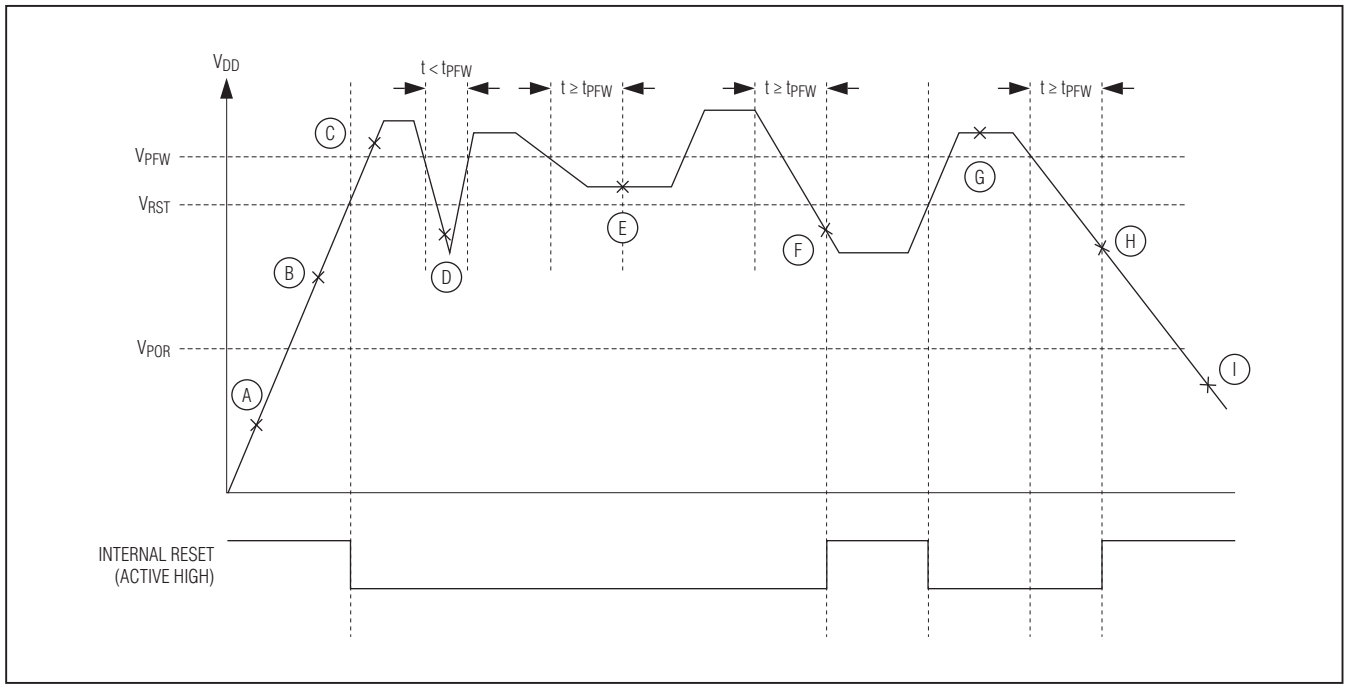


Figure 5. Power-Fail Detection During Normal Operation

Table 5. Power-Fail Detection States During Normal Operation

STATE	POWER-FAIL	INTERNAL REGULATOR	CRYSTAL OSCILLATOR	SRAM RETENTION	COMMENTS
A	On	Off	Off	—	$V_{DD} < V_{POR}$.
B	On	On	On	—	$V_{POR} < V_{DD} < V_{RST}$. Crystal warmup time, t_{XTAL_RDY}. CPU held in reset.
C	On	On	On	—	$V_{DD} > V_{RST}$. CPU normal operation.
D	On	On	On	—	Power drop too short. Power-fail not detected.
E	On	On	On	—	$V_{RST} < V_{DD} < V_{PFW}$. PFI is set when $V_{RST} < V_{DD} < V_{PFW}$ and maintains this state for at least t_{PFW}, at which time a power-fail interrupt is generated (if enabled). CPU continues normal operation.
F	On (Periodically)	Off	Off	Yes	$V_{POR} < V_{DD} < V_{RST}$. Power-fail detected. CPU goes into reset. Power-fail monitor turns on periodically.
G	On	On	On	—	$V_{DD} > V_{RST}$. Crystal warmup time, t_{XTAL_RDY}. CPU resumes normal operation from 8000h.
H	On (Periodically)	Off	Off	Yes	$V_{POR} < V_{DD} < V_{RST}$. Power-fail detected. CPU goes into reset. Power-fail monitor turns on periodically.
I	Off	Off	Off	—	$V_{DD} < V_{POR}$. Device held in reset. No operation allowed.

nanopower ring-oscillator cycles. If $V_{DD} > V_{RST}$ during detection, V_{DD} is monitored for an additional nanopower ring-oscillator period. If V_{DD} remains above V_{RST} for the third nanopower ring period, the CPU exits the reset state and resumes normal operation from utility ROM at 8000h after satisfying the crystal warmup period.

If a reset is generated by any other event, such as the $\overline{\text{RESET}}$ pin being driven low externally or the watchdog timer, the power-fail, internal regulator, and crystal remain on during the CPU reset. In these cases, the CPU exits the reset state in less than 20 crystal cycles after the reset source is removed.

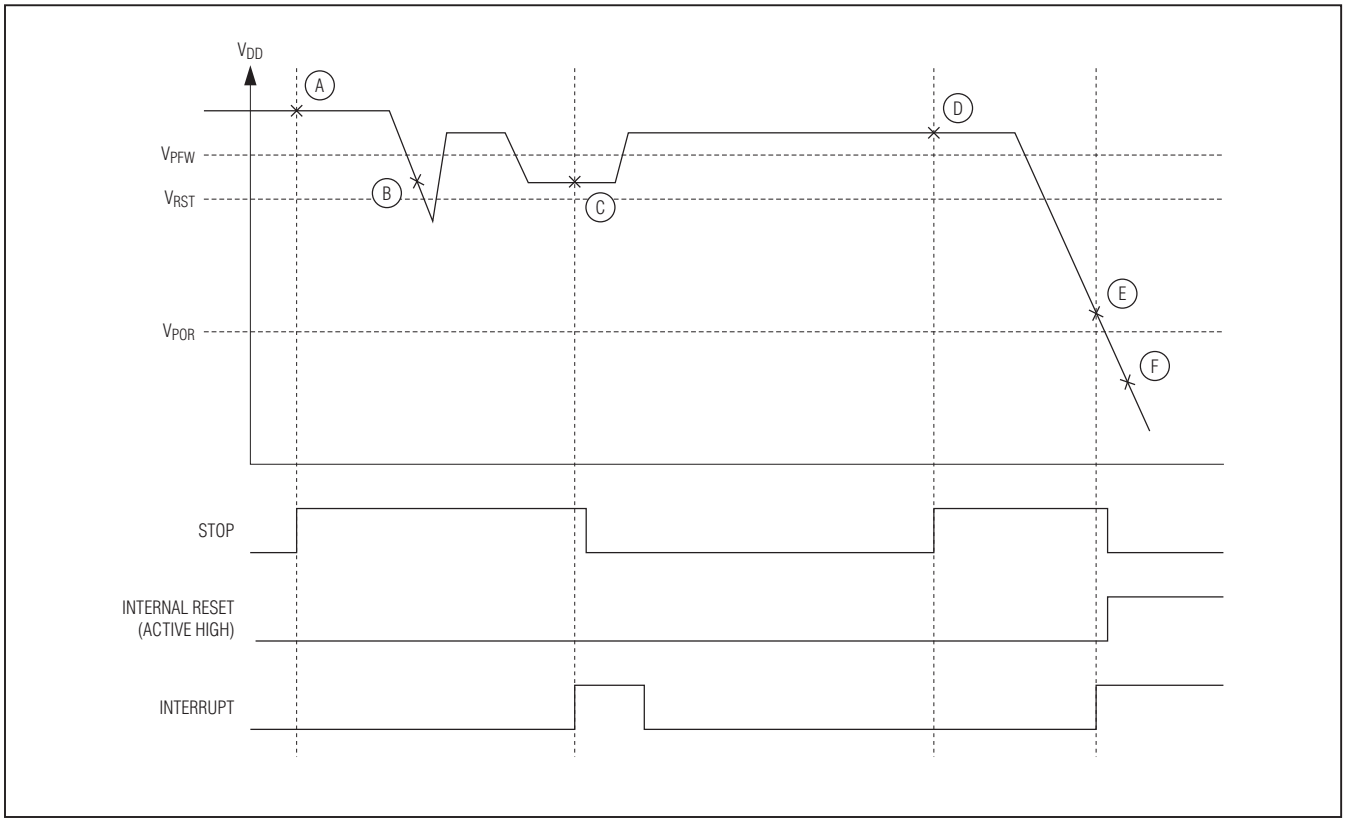


Figure 7. Stop Mode Power-Fail Detection with Power-Fail Monitor Disabled

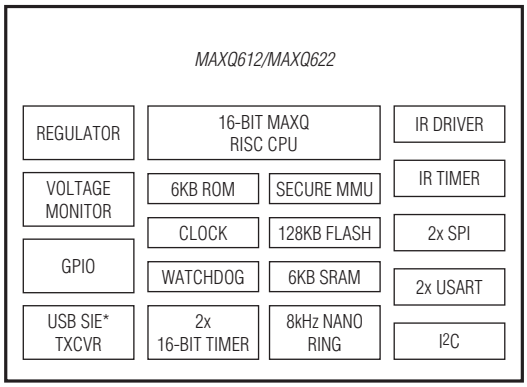
Table 7. Stop Mode Power-Fail Detection States with Power-Fail Monitor Disabled

STATE	POWER-FAIL	INTERNAL REGULATOR	CRYSTAL OSCILLATOR	SRAM RETENTION	COMMENTS
A	Off	Off	Off	Yes	Application enters stop mode. $V_{DD} > V_{RST}$. CPU in stop mode.
B	Off	Off	Off	Yes	$V_{DD} < V_{PFW}$. Power-fail not detected because power-fail monitor is disabled.
C	On	On	On	Yes	$V_{RST} < V_{DD} < V_{PFW}$. An interrupt occurs that causes the CPU to exit stop mode. Power-fail monitor is turned on, detects a power-fail warning, and sets the power-fail interrupt flag. Turn on regulator and crystal. Crystal warmup time, t_{XTAL_RDY}. On stop mode exit, CPU vectors to the higher priority of power-fail and the interrupt that causes stop mode exit.

MAXQ612/MAXQ622

16-Bit Microcontrollers with Infrared Module and Optional USB

Block Diagram



Development and Technical Support

Maxim and third-party suppliers provide a variety of highly versatile, affordably priced development tools for this microcontroller, including the following:

- Compilers
- In-circuit emulators
- Integrated Development Environments (IDEs)
- JTAG-to-serial converters for programming and debugging

A partial list of development tool vendors can be found at **www.maximintegrated.com/MAXQ_tools**.

For technical support, go to **https://support.maximintegrated.com/micro**.

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maximintegrated.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
64 LQFP	C64+5	21-0083	90-0141
44 TQFN-EP	T4477+2	21-0144	90-0127

Ordering Information/Selector Guide

PART	TEMP RANGE	OPERATING VOLTAGE (V)	PROGRAM MEMORY (KB)	DATA MEMORY (KB)	USB FULL SPEED	PIN-PACKAGE
MAXQ612J-0000+	0°C to +70°C	1.7 to 3.6	128 Flash	6	No	44 TQFN-EP*
MAXQ612G-0000+	0°C to +70°C	1.7 to 3.6	128 Flash	6	No	64 LQFP
MAXQ622G-0000+	0°C to +70°C	1.7 to 3.6	128 Flash	6	Yes	64 LQFP

Note: *The 4-digit suffix "-0000" indicates a microcontroller in the default state with the flash memory unprogrammed. Any value other than 0000 indicates a device preprogrammed at Maxim with proprietary customer-supplied software. For more information on factory preprogramming of these devices, contact Maxim at https://support.maximintegrated.com/micro. Information on masked ROM devices and bare die versions for most of these devices are available. Contact the factory for availability.*

+Denotes a lead(Pb)-free/RoHS-compliant package.

**EP = Exposed pad.*

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/10	Initial release	—
1	5/10	Changed the V_{DDIOH} spec for I_{OH} from I_{OH} = 20mA to I_{OH} = 10mA in the *Recommended Operating Conditions* table	5
2	5/11	Added the *Pin Descriptions—Bare Die* table	18–21