MICROLINK 302x

Timing and Counting

User Manual

Biodata Limited

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Counters and Timers

The 302x range provides numerous timing and counting options. There are 3 modules in the range: the 3020, 3021 and 3022.

The 3020 has 8 independent 16-bit counters. Each counter is an event (totalise) counter and can be individually read and reset. The counts can be cascaded to allow longer counts.

The 3021 also has 8 independent 16-bit counters. These can be used in one of 2 modes: event or frequency.

The 3022 has 1 counter which can be used in one of 4 modes: frequency; period; up/down counter or timer.

The operating mode is set from software.

All the modules have 37-way D type connectors. Alternatively you can connect your signals to screw terminals with a 390x module. The 390x modules also provide extra facilities, such as input protection, when the appropriate components are fitted. See Chapter 11 for details.

4.1 3020/3021—Eight 16-Bit Counters

The 3020 provides 8 independent 16-bit counters, which can each count up to 65535. The counters are event counters.

The 3021 has 8 counters of 16-bit resolution which can be either event or frequency counters. At power-up all counters will be in event mode. Each counter can be individually set into event or frequency mode from software.

In frequency mode 4 gate times are available: 0.01, 0.1, 1 and 10 seconds. On the 1 second range, for example, the 3021 will count the number of input cycles occurring in 1 second.

Each counter of both the 3020 and 3021 has a CLOCK input, an ENABLE input and a CARRY output.

4.1.1 Connection Notes

The connections for the 3020 and 3021 are identical.

Input Voltages

The inputs are TTL and 5 V CMOS compatible. Each input is pulled high by a 100K resistor. The input voltages should not go outside the 0 to 5 V range. The 3900 Screw Terminal module can be used to mount components providing input protection or higher voltage inputs.

Opto-Isolated Inputs

These can be provided by the 3801 isolated input module.

Outputs

The carry outputs are TTL and 5 V CMOS compatible. They are capable of driving 10 LSTTL loads.

CLOCK Inputs

The counters advance on falling edges at their clock inputs.

ENABLE Inputs

A counter can only advance when its enable input is high. The 100K pull up resistors fitted to these inputs mean that they can be left unconnected if not required. Changes of state at the enable inputs will not cause the counter to advance.

CARRY Outputs

You can count more than 65535 events by cascading two or more counters. Connect the CARRY output of one counter to the CLOCK input of the next. Leave the ENABLE input of this second counter unconnected. The CARRY output is a high going pulse lasting for 256 input counts. The falling edge marks the actual carry point.

Table 4.1 3020/3021 - 8 Counters
Pin Connections for 37-Way D Plug (Wiring View)

		19	0 V
5 V	37		
		18	unused
unused	36		
		17	unused
unused	35		
		16	CARRY 0
CLOCK 0	34		
		15	ENABLE 0
unused	33		
		14	CARRY 1
CLOCK 1	32		
		13	ENABLE 1
unused	31		
		12	CARRY 2
CLOCK 2	30		
		11	ENABLE 2
unused	29		
		10	CARRY 3
CLOCK 3	28		
		9	ENABLE 3
unused	27		
		8	CARRY 4
CLOCK 4	26		
		7	ENABLE 4
unused	25		
		6	CARRY 5
CLOCK 5	24		
		5	ENABLE 5
unused	23		
		4	CARRY 6
CLOCK 6	22		
		3	ENABLE 6
unused	21		
		2	CARRY 7
CLOCK 7	20		
		1	ENABLE 7

Please read the Connection Notes on the previous pages before making your connections.

4.2 3022—24-Bit Counter

The 3022 module provides a single 24-bit counter which can be either an up/down counter, a frequency counter, a period timer or a start/stop timer. Use software to select the type of counter or timer. When in up/down counter mode, the direction of counting can be controlled either by software or by a hardware input. A gate input is also available to enable or disable counting. An output is provided to indicate when the counter reaches zero.

In frequency mode 4 gate times are available: 0.01, 0.1, 1.0 and 10 seconds. The module will count the number of cycles occurring at its input during these gate times. At the end of a gate time the output latches are updated, the count is reset to zero and the measurement restarts.

In period mode the module measures the time for 1, 10, 100 or 1000 cycles of the input signal. The unit of measurement is 0.1 microseconds. At the end of each measurement the output latches are updated, the counter is reset to zero and the measurement restarts.

In timer mode the module measures the time that a signal is true, or the time between a start and stop pulse. The unit of measurement is 0.1 microseconds.

4.2.1 Connection Notes

Inputs

All inputs are TTL, 5 V CMOS compatible. They are all pulled high by 100 K resistors. Voltages applied should be restricted to the range 0–5 V.

Outputs

All Outputs are TTL and 5 V CMOS compatible. They are capable of driving 10 LSTTL loads.

Main Counter Controls

There are three signals: COUNT, DOWN/UP and ENABLE. In up/down counter mode a positive edge at the COUNT input will advance the counter if the ENABLE input is high. Changes of state on the ENABLE input will not cause false counts. The module will count up if the DOWN/UP input is low. It will count down if the DOWN/UP input is high.

In frequency or period mode the measured signal should be applied to the COUNT input. The ENABLE and DOWN/UP inputs are not required and are internally disconnected.

In timer mode the COUNT input is internally switched to the 10 MHz clock. The DOWN/UP input is internally disconnected. The ENABLE input controls the timing since the counter advances at 10 MHz whenever the ENABLE is high. The DOWN/UP input and the ENABLE input are read by software. In modes where the ENABLE or DOWN/UP inputs are internally disconnected, they may be used as auxiliary inputs.

In the *3300 Programming Manual* the ENABLE input is called START/STOP.

ZERO Outputs

The ZERO output goes high when the counter contains 0. The Not ZERO is simply its inverse.

D4, 5, 6, 7 OUTPUTS

These four output lines are controlled by software. In IML software D5 OUTPUT is designated DOWN/UP output. It is intended to be connected to the DOWN/UP input to give software direction control. Likewise D6 OUTPUT is designated START/STOP output and is intended for connection to the ENABLE input. These connections should only be made when required by the application. D7 OUTPUT is unique in that it can also be read by the software as D7 of the mode byte. Any of these outputs can be freely used as required by the application.

Timing Flip-Flop

Two outputs and four inputs give full control over a D type flip-flop (74HC74), which is useful for timing applications. The Truth Table of the FF (flip-flop) is:

CLOCK	D	Not SET	Not RESET	Q	Not Q
X	X	1	0	0	1
X	X	0	1	1	0
X	X	0	0	1	1
?	0	1	1	0	1
?	1	1	1	1	0

In timing applications three points must always be considered:

1. How to start the timing
2. How to stop the timing
3. How to initialise the counter to “stop” before start occurs.

Some examples are given below.

Timing with Separate Start and Stop Pulses

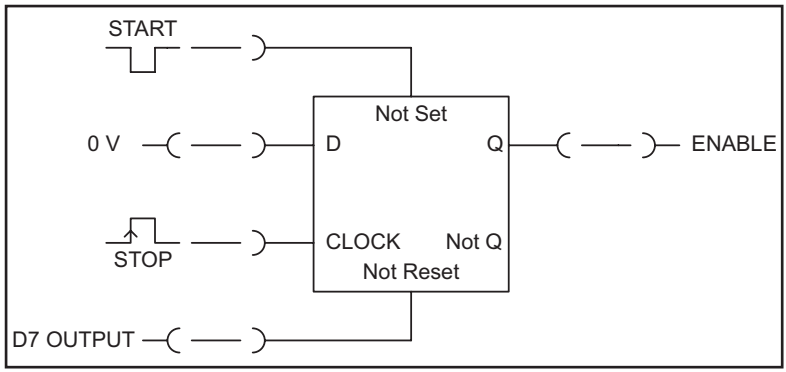

Figure 4.1 Timing with Separate Start and Stop Pulses

The D7 OUTPUT is used to initialise the FF to the “stop” state. A negative going pulse sets the FF and so starts the timing. A rising edge at the CLOCK resets the FF and so stops the timing. The Q of the FF controls the ENABLE and so the timing.

Software Start - Hardware Stop

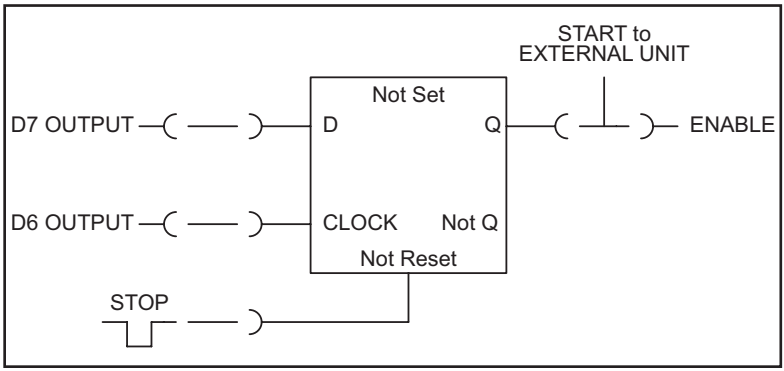

Figure 4.2 Software Stop—Hardware Stop

The FF can be initialised by setting the D7 OUTPUT low and producing a positive edge on D6 OUTPUT. Software start is produced by setting D7 OUTPUT high and producing a positive edge on D6 OUTPUT. A low level on Not RESET stops the unit. The Q output of the FF can be used to trigger the system being investigated.

Start and Stop Pulses on the Same Line

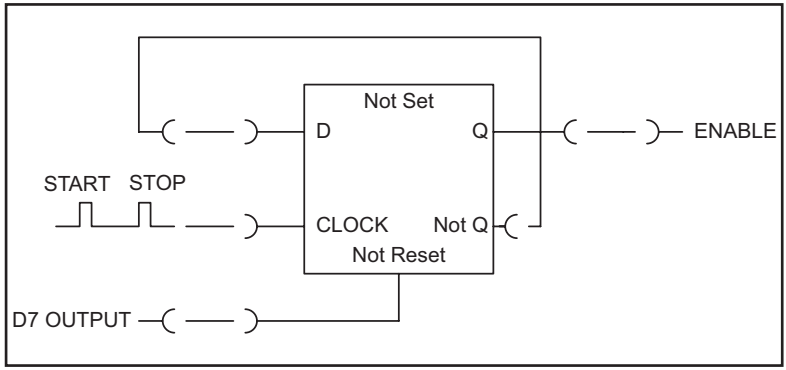

Figure 4.3 Start and Stop Pulses on the Same Line

The FF can be initialise by setting D7 OUTPUT low. The FF then changes state at each rising edge on its CLOCK input.

Table 4.2 3022 - 1 24-Bit Counter
Pin Connections for 37-Way D Plug (Wiring View)

		19	0 V
5 V	37		
		18	FF Not Q
unused	36		
		17	FF Q
Not ZERO	35		
		16	FF CLOCK
ZERO	34		
		15	FF Not SET
unused	33		
		14	FF D
unused	32		
		13	FF Not RESET
unused	31		
		12	COUNT
unused	30		
		11	DOWN/UP
unused	29		
		10	ENABLE
unused	28		
		9	D5 OUTPUT
unused	27		
		8	D6 OUTPUT
unused	26		
		7	D7 OUTPUT
unused	25		
		6	10 MHz
unused	24		
		5	D4 OUTPUT
unused	23		
		4	unused
unused	22		
		3	unused
unused	21		
		2	unused
unused	20		
		1	unused

Please read the Connection Notes on the previous page before making your connections.

4.3 302x Specifications

4.3.1 3020 and 3021 Specifications

Number of counters	8
Resolution	16 bits
Event counter	3020 and 3021
Frequency counter	3021 only
Maximum input frequency	10 MHz
Compatibility	TTL and 5 V CMOS
Input voltage range	0 to 5 V
Carry outputs drive	10 LSTTL loads

3021 Frequency Measurement

Clock reference	1 MHz crystal oscillator
Gate times	0.01, 0.1, 1 and 10 seconds

4.3.2 3022 Specifications

Number of counters	1
Resolution	24 bits
Counter type	up/down, frequency, start/stop, period
Maximum input frequency	10 MHz
Compatibility	TTL and 5 V CMOS
Input voltage range	0 to 5 V
Carry outputs drive	10 LSTTL loads
Clock reference	1 MHz crystal oscillator
Gate times	0.01, 0.1, 1 and 10 seconds (frequency mode only)
Number of cycles timed	1, 10, 100 or 1000 (period mode only)