K148T3. 40KHz Auto Ranging Frequency Meter

The third in a series of timer kits based on the K148 hardware platform. This module will measure frequency up to 40KHz in two ranges: above and below 10KHz. Range switching is automatic. Output is via a 4-digit 7-segment display.

Refer to the "**K148 4-DIGIT TIMING MODULE**" documentation for details of hardware features, circuit description and assembly instructions.

FREQUENCY METER SPECIFICATIONS

Ranges	0 to 9.999KHz 10 to 40KHz (approx)
Gating Signal	Internal 0.1 second for < 10KHz 1 second for > 10KHz
Resolution	1Hz for < 10KHz 10Hz for > 10KHz
Inputs	Start pins. LO, 0-0.9V; HI 1.2V – 5.0V
Output	Open collector NPN transistor, 100mA @ 30V
Display	4-digit 7-segment with decimal point, 14mm RED LED
Supply voltage	9 to 12V DC
Supply current	30 to 50mA, depending on the number displayed.
Physical size	51mm x 66mm (2.0" x 2.6")
Connection	10-way right-angle SIL header pins, 0.1" spacing

BASIC FREQUENCY MEASUREMENT THEORY

Measuring frequency is a matter of counting the number of cycles in a given time interval. If the time interval is 1 second then the number of cycles counted is a direct reading of the frequency. The unit of frequency is Hertz (Hz) or 'cycles per second'. This time interval is often referred to as 'gate time' or 'gating signal'.

Using a 1 second gating signal is not always possible. The problem is in displaying the result. If using a 4-digit display, as in this kit, then the maximum display value is '9999'. If a 1 second gate signal was used then this limits the maximum frequency that can be displayed to 9999Hz (9.999KHz).

This can be overcome by using more digits in the display. A 6-digit display can show up to 999999Hz (999.999KHz). What happens after that? You can't go on simply tacking on more digits.

The solution is to reduce the gate time, thereby reducing the number of counts. For example, assume we have a 4-digit display and we want to measure a 10KHz signal. The result (10000) cannot be displayed in 4 digits. If the gating time is reduced to 0.1 seconds then the count value becomes '1000' which can be displayed. Of course the actual frequency is ten times that.

This now brings us to the problem of resolution. As can be seen from the previous example the last digit is 'lost' when measuring a 10KHz signal. Therefore this is said to have a resolution of 10Hz because a 10Hz variation is required before the last display digit will change.

If the signal is less than 10KHz we can use a 1 second gate time to measure it and still be able to display it fully. In this case the resolution is 1Hz because the display will change if the signal varies by that small amount.

Gating signals are normally sub-multiples of 1 second, for example 0.1, 0.01, etc. This makes it easy to display the result – all we have to do is shift around the decimal point to indicate whether the reading is in Hz or KHz or MHz.

Using gating times such as 0.2 or 0.5 seconds produces odd readings. For example if the gating time was 0.5 seconds and the frequency being measured was 1KHz the reading would be 500. This may be desirable in some cases where a conversion is required between the actual measured signal and the displayed reading.

OPERATING INSTRUCTIONS

A frequency cycle is measured by a **HI** to **LO** transition at the **START** pair of pins. A **HI** is defined for the Atmel uC as 1.2V – 5.0V DC. A **LO** is 0.0V – 0.9V DC.

In other applications of firmware for k148 just shorting out the pins mechanically has been sufficient. However, in this case we are electrically short circuiting the pins so the voltage ranges must be specified.

Connect a TTL level square wave signal (for example, from out Kit 101) to the '+' start input pin and the module does the rest. Remember to common all ground connections.

The kit uses two gate signals (ranges) to measure frequency. By default a 1 second gate signal (low range) is used on power up. If the frequency exceeds 9999Hz then an internal 'overflow' condition occurs and the kit automatically switches to a 0.1 second gate signal (high range). When the frequency drops below 10,000Hz it switches back to low range.

The display reading is **always** in 'KHz', with the position of the decimal point indicating the range. In 'low' range the maximum display reading is '**9.999**' KHz. In 'high' range the maximum display reading is '**99.99**' KHz.

The maximum frequency the kit can measure is around 40KHz.

Note: In low range the display only updates every second. In high range it updates every tenth of a

second. Low range is more accurate but high range will respond more quickly to frequency variations.
The STOP pair of pins are NOT used in this module.

The open collector output is 'active' when the counter is in high range. It can be used to drive an external light or LED to indicate that the input frequency is greater than 9999Hz. For more information about what an open collector output is read the note at

www.kitsrus.com/zip/opencol.txt

INPUT SIGNAL CONDITIONING
Input to the kit is pulled high to 5 volts via a 10K resistor (refer to K148 schematic). It can be driven by any 5V logic output circuit. This is fine when working with digital circuits but that may not always be the case. What if we want to measure a low-level signal as found in audio preamplifiers? This may be as low as a few millivolts and therefore needs to be amplified and 'shaped' before applied to the kit input.

The figure shows a basic design for a simple, broadband preamplifier that could be used to condition the input signal before connecting to the counter input. There are many other circuits that could be used to do the job. This one is offered as an example.

Q1 is a MOSFET that amplifies the input signal. Diodes D1 and D2 limit any excessive voltage so Q1 will not be damaged. Q2 is a high-speed NPN transistor that further amplifies the signal to a level that will trigger the counter module. This circuit can easily be built on some perforated board. Keep lead lengths short to avoid oscillation.

CONNECTING TO THE KIT
A 10-way header strip provides external connection to the timer, including power. All the inputs and the output are organized as 'pairs' of pins, with each input or output having a corresponding ground pin, as per the following diagram.

Note: When using the output to switch a load (relay, buzzer, etc) connect the load between the output pin and a positive DC voltage. For example, if switching a 12V relay connect the relay between the output pin and +12V.

OTHER TIMING MODULES
There are other firmware ICs available for k148:

1. **K148T1** Simple Photographic Timer
2. **K148T2** Stopwatch with Pause function
3. **K148T0** Programmable Down Timer counting down in seconds from a maximum of 10,000 sec
4. **K148T4** Programmable Down Timer counting down in minutes from a max of 10,000 minutes
5. **K148T5** Programmable Down Timer counting down in hours from a max of 10,000 seconds

See out website at **www.kitsrus.com** for details.

If you have any questions or changes you can contact the kit developer at **frank@ozitronics.com**

Please note we do not provide the source code for any of our firmware.