



### Description

The MK1709 generates a low EMI output clock from a clock input. The part is designed to dither the LCD interface clock for flat panel graphics controllers. The device uses ICS' proprietary mix of analog and digital Phase Locked Loop (PLL) technology to spread the frequency spectrum of the output, thereby reducing the frequency amplitude peaks by several dB.

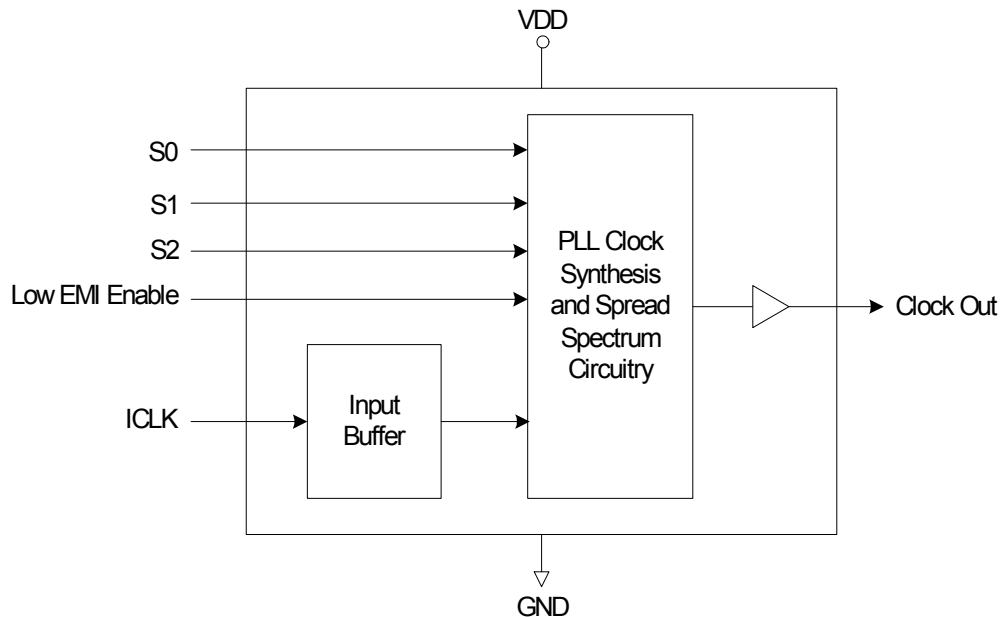
The MK1709 offers centered spread from a high speed clock input. Refer to the MK1714-01/02 for a crystal input and the widest selection of input frequencies and multipliers.

ICS offers many other clocks for computers and computer peripherals. Consult us when you need to remove crystals and oscillators from your board.

### Features

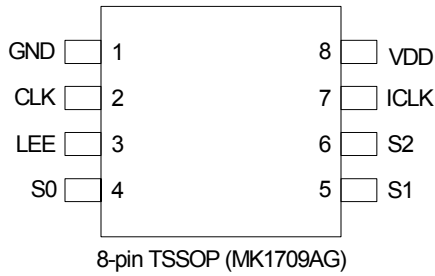
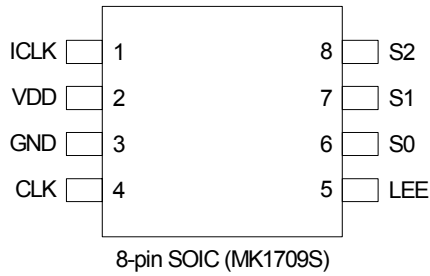
- Packaged in 8-pin SOIC (MK1709S) and in 8-pin TSSOP (MK1709AG)
- 8-pin TSSOP available in lead (Pb) free package
- Provides a spread spectrum output clock
- Supports flat panel controllers
- Guaranteed to +85°C operation
- Accepts a clock input, provides same frequency dithered output
- Good for all VGA modes from 80 to 167 MHz
- Peak reduction by 7dB - 14dB typical on 3rd - 19th odd harmonics
- Low EMI feature can be disabled
- Includes power-down
- Operating voltage of 3.3 V
- Advanced, low-power CMOS process

### Block Diagram





### Pin Assignment



### Spread Percentage and Direction Select Table

| S2<br>Pin 8<br>(1709S)<br>Pin 6<br>(1709AG) | S1<br>Pin 7<br>(1709S)<br>Pin 5<br>(1709AG) | S0<br>Pin 6<br>(1709S)<br>Pin 4<br>(1709AG) | Frequency<br>Range                        | Spread<br>Percentage<br>(%) |
|---|---|---|---|-----------------------------|
| 0   | 0   | 0   | 40-50                                     | ±0.9                        |
| 0   | 0   | M   | 40-50                                     | ±0.7                        |
| 0   | 0   | 1   | 40-50<br>(MK1709S)<br>25-50<br>(MK1709AG) | ±0.8                        |
| 0   | M   | 0   | 40-50<br>(MK1709S)<br>25-50<br>(MK1709AG) | ±0.6                        |
| 0   | M   | M   | 40-50                                     | ±1.1                        |
| 0   | M   | 1   | 50 -100                                   | ±0.6                        |
| 0   | 1   | 0   | 50 -100                                   | ±0.7                        |
| 0   | 1   | M   | 50 -100                                   | ±0.8                        |
| 0   | 1   | 1   | Power Down                                | —                           |
| 1   | 0   | 0   | 50 -100                                   | ±0.9                        |
| 1   | 0   | M   | 50 -100                                   | ±1.1                        |
| 1   | 0   | 1   | 100-165                                   | ±0.7                        |
| 1   | M   | 0   | 100-165                                   | ±0.6                        |
| 1   | M   | M   | 100-165                                   | ±1.1                        |
| 1   | M   | 1   | 100-165                                   | ±1.35                       |
| 1   | 1   | 0   | 100-165                                   | ±0.8                        |
| 1   | 1   | M   | 100-165                                   | ±0.9                        |
| 1   | 1   | 1   | Power Down                                | —                           |

0 = connect to GND

M = unconnected (floating) has internal Pull up resistor to VDD and is considered as a 1 state

1 = connect directly to VDD



## Pin Descriptions (MK1709S)

| Pin Number | Pin Name | Pin Type | Pin Description   |
|------------|----------|----------|---|
| 1          | ICLK     | Input    | Connect to graphics input clock.  |
| 2          | VDD      | Power    | Connect to +3.3 V.  |
| 3          | GND      | Power    | Connect to ground.  |
| 4          | CLK      | Output   | Spread spectrum clock output per table above.   |
| 5          | LEE      | Input    | Low EMI enable. Turns on spread spectrum when high. Internal pull-up resistor.                    |
| 6          | S0       | Input    | Function select 0 input. Selects spread amount and direction per table above. Internal mid-level. |
| 7          | S1       | Input    | Function select 1 input. Selects spread amount and direction per table above. Internal mid-level. |
| 8          | S2       | Input    | Function select 2 input. Selects spread amount and direction per table above.                     |

## Pin Descriptions (MK1709AG)

| Pin Number | Pin Name | Pin Type | Pin Description   |
|------------|----------|----------|---|
| 1          | GND      | Power    | Connect to ground.  |
| 2          | CLK      | Output   | Spread spectrum clock output per table above.   |
| 3          | LEE      | Input    | Low EMI enable. Turns on spread spectrum when high. Internal pull-up resistor.                    |
| 4          | S0       | Input    | Function select 0 input. Selects spread amount and direction per table above. Internal mid-level. |
| 5          | S1       | Input    | Function select 1 input. Selects spread amount and direction per table above. Internal mid-level. |
| 6          | S2       | Input    | Function select 2 input. Selects spread amount and direction per table above.                     |
| 7          | ICLK     | Input    | Connect to graphics input clock.  |
| 8          | VDD      | Power    | Connect to +3.3 V.  |



## External Components

The MK1709 requires a minimum number of external components for proper operation.

### Decoupling Capacitor

A decoupling capacitor of 0.01 $\mu$ F must be connected between VDD and GND on pins 2 and 3 for the MK1709S, or pins 1 and 8 for the MK1709AG. Place the capacitor as close to these pins as possible. For optimum device performance, the decoupling capacitor should be mounted on the component side of the PCB. Avoid the use of vias in the decoupling circuit.

### Series Termination Resistor

When the PCB trace between the clock output and the load is over 1 inch, series termination should be used. To series terminate a 50 $\Omega$  trace (a commonly used trace impedance), place a 33 $\Omega$  resistor in series with the clock line, as close to the clock output pin as possible. The nominal impedance of the clock output is 20 $\Omega$ .

### Select Pin Operation

The S1, S0 select pins are 2-level, meaning they have three separate states to make the selections shown in the table on page 2.

## PCB layout Recommendations

For optimum device performance and lowest output phase noise, the following guidelines should be observed.

- 1) The 0.01 $\mu$ F decoupling capacitor should be mounted on the component side of the board as close to the VDD pin as possible. No vias should be used between the decoupling capacitor and VDD pin. The PCB trace to VDD pin should be kept as short as possible, as should the PCB trace to the ground via.
- 2) Place a 33 $\Omega$  series termination resistor (if needed) close to the clock output to minimize EMI.
- 3) An optimum layout is one with all components on the same side of the board, minimizing vias through other signal layers. Other signal traces should be routed away from the MK1709. This includes signal traces just underneath the device, or on layers adjacent to the ground plane layer used by the device.



## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the MK1709. These ratings, which are standard values for ICS commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range. Typical values are at 25°C.

| Item  | Rating              |
|---|---------------------|
| Supply Voltage, VDD (referenced to GND)       | 5 V                 |
| All Inputs and Outputs (referenced to GND)    | -0.5 V to VDD+0.5 V |
| Ambient Operating Temperature                 | 0 to +85°C          |
| Storage Temperature                           | -65 to +150°C       |
| Soldering Temperature (maximum of 10 seconds) | 260°C               |

## Recommended Operation Conditions

| Parameter   | Min.   | Typ. | Max. | Units |
|---|--------|------|------|-------|
| Ambient Operating Temperature                     | 0      |      | +85  | °C    |
| Power Supply Voltage (measured in respect to GND) | +3.135 |      | +3.6 | V     |

## DC Electrical Characteristics

Unless stated otherwise, VDD = 3.3 V, Ambient Temperature 0 to +85°C

| Parameter                         | Symbol          | Conditions               | Min.      | Typ.  | Max.      | Units |
|-----------------------------------|-----------------|--------------------------|-----------|-------|-----------|-------|
| Operating Voltage                 | VDD             |                          | 3.135     |       | 3.465     | V     |
| Supply Current (MK1709S)          | IDD             | No load, at 3.3 V        |           | 20    |           | mA    |
| Supply Current (MK1709AG)         | IDD             | No load, 50M             |           | 13    |           | μA    |
|                                   |                 | No load, 150M            |           | 23    |           |       |
| Input High Voltage (ICLK)         | V <sub>IH</sub> |                          | (VDD/2)+1 | VDD/2 |           | V     |
| Input High Voltage (S1, S0)       | V <sub>IH</sub> |                          | VDD-0.5   |       |           | V     |
| Input High Voltage (other inputs) | V <sub>IH</sub> |                          | 2         |       |           | V     |
| Input Low Voltage (ICLK)          | V <sub>IL</sub> |                          |           | VDD/2 | (VDD/2)-1 | V     |
| Input Low Voltage                 | V <sub>IL</sub> |                          |           |       | 0.5       | V     |
| Output High Voltage (CMOS)        | V <sub>OH</sub> | I <sub>OH</sub> = -4mA   | VDD-0.4   |       |           | V     |
| Output High Voltage               | V <sub>OH</sub> | I <sub>OH</sub> = -12 mA | 2.4       |       |           | V     |
| Output Low Voltage                | V <sub>OL</sub> | I <sub>OL</sub> = 12 mA  |           |       | 0.4       | V     |
| Input Capacitance                 | C <sub>IN</sub> | S0, S1, S2, LEE pins     |           | 7     |           | pF    |



## AC Electrical Characteristics (MK1709S)

Unless stated otherwise, **VDD = 3.3 V**, Ambient Temperature 0 to +85° C

| Parameter                    | Symbol          | Conditions               | Min. | Typ.    | Max. | Units |
|------------------------------|-----------------|--------------------------|------|---------|------|-------|
| Input/Output Clock Frequency |                 |                          | 80   |         | 167  | MHz   |
| Input Clock Duty Cycle       |                 | Time above VDD/2         | 20   |         | 80   | %     |
| Output Clock Duty Cycle      |                 | Time above 1.5 V         | 40   | 50      | 60   | %     |
| Output Clock Rise Time       | t <sub>OR</sub> | 0.8 to 2.0V              |      | 1.5     |      | ns    |
| Output Clock Fall Time       | t <sub>OF</sub> | 2.0 to 0.8V              |      | 1.5     |      | ns    |
| EMI Peak Frequency Reduction |                 | 3rd - 19th odd harmonics |      | 7 to 14 |      | dB    |

## AC Electrical Characteristics (MK1709AG)

Unless stated otherwise, **VDD = 3.3 V**, Ambient Temperature 0 to +85° C

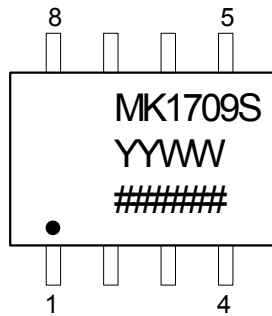
| Parameter                    | Symbol          | Conditions                             | Min. | Typ.    | Max. | Units |
|------------------------------|-----------------|--|------|---------|------|-------|
| Input/Output Clock Frequency |                 |  | 25   |         | 165  | MHz   |
| Input Clock Duty Cycle       |                 | Time above VDD/2                       | 20   |         | 80   | %     |
| Output Clock Duty Cycle      |                 | Time above 1.5 V,<br>40 MHz - 100 MHz  | 40   | 50      | 55   | %     |
|                              |                 | Time above 1.5 V,<br>100 MHz - 150 MHz |      | 45      |      | %     |
|                              |                 | Time above 1.5 V,<br>>150 MHz          |      | 35      |      | %     |
| Output Clock Rise Time       | t <sub>OR</sub> | 0.8 to 2.0V                            |      |         | 1.5  | ns    |
| Output Clock Fall Time       | t <sub>OF</sub> | 2.0 to 0.8V                            |      |         | 1.5  | ns    |
| EMI Peak Frequency Reduction |                 | 3rd - 19th odd harmonics               |      | 7 to 14 |      | dB    |

## Spread Spectrum Modulation Rate

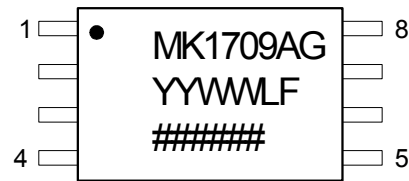
For 40 to 50 MHz selections, modulation rate = input frequency/1028; for 50 to 100 MHz selections, modulation rate = input frequency/2056; for 100 to 165 MHz selections, modulation rate = input frequency/4112.



### Marking Diagrams

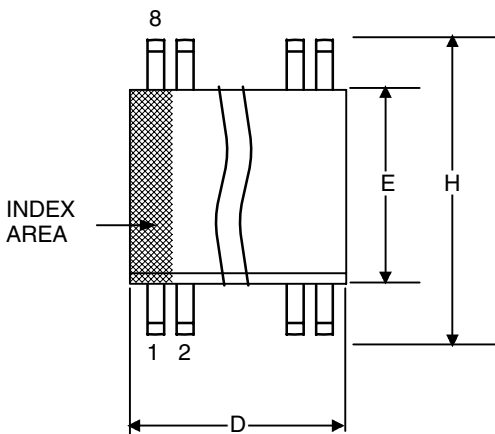


### Marking for lead (Pb) free device

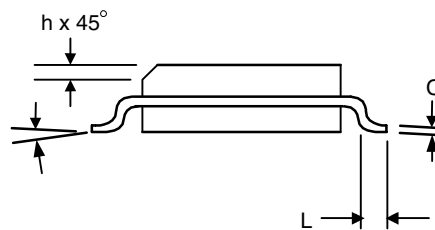
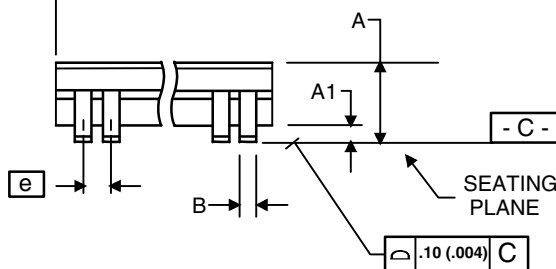


### Package Outline and Package Dimensions (8-pin SOIC, 150 Mil. Body)

Package dimensions are kept current with JEDEC Publication No. 95



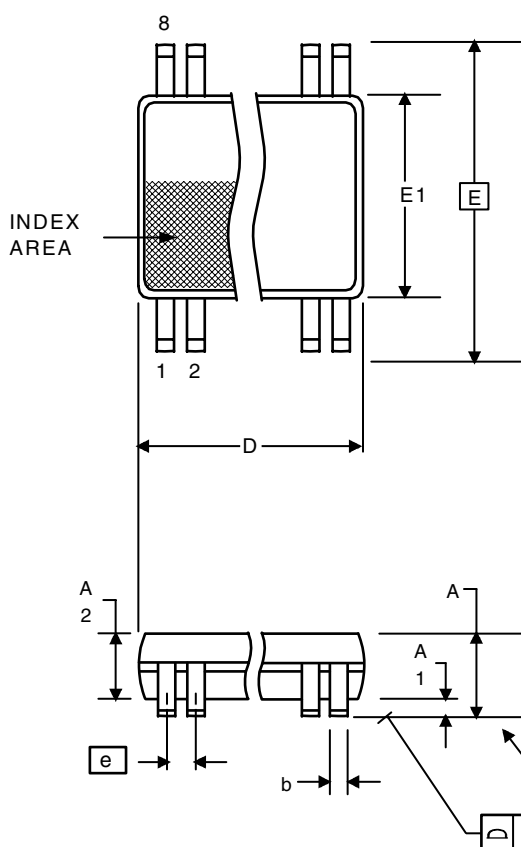
| Symbol   | Millimeters |      | Inches      |       |
|----------|-------------|------|-------------|-------|
|          | Min         | Max  | Min         | Max   |
| A        | 1.35        | 1.75 | .0532       | .0688 |
| A1       | 0.10        | 0.25 | .0040       | .0098 |
| B        | 0.33        | 0.51 | .013        | .020  |
| C        | 0.19        | 0.25 | .0075       | .0098 |
| D        | 4.80        | 5.00 | .1890       | .1968 |
| E        | 3.80        | 4.00 | .1497       | .1574 |
| e        | 1.27 BASIC  |      | 0.050 BASIC |       |
| H        | 5.80        | 6.20 | .2284       | .2440 |
| h        | 0.25        | 0.50 | .010        | .020  |
| L        | 0.40        | 1.27 | .016        | .050  |
| $\alpha$ | 0°          | 8°   | 0°          | 8°    |





### Package Outline and Package Dimensions (8-pin TSSOP, 173 Mil. Body)

Package dimensions are kept current with JEDEC Publication No. 95



| Symbol   | Millimeters |      | Inches       |       |
|----------|-------------|------|--------------|-------|
|          | Min         | Max  | Min          | Max   |
| A        | --          | 1.20 | --           | 0.047 |
| A1       | 0.05        | 0.15 | 0.002        | 0.006 |
| A2       | 0.80        | 1.05 | 0.032        | 0.041 |
| b        | 0.19        | 0.30 | 0.007        | 0.012 |
| C        | 0.09        | 0.20 | 0.0035       | 0.008 |
| D        | 3.90        | 3.10 | 0.114        | 0.122 |
| E        | 6.40 BASIC  |      | 0.252 BASIC  |       |
| E1       | 4.30        | 4.50 | 0.169        | 0.177 |
| e        | 0.65 Basic  |      | 0.0256 Basic |       |
| L        | 0.45        | 0.75 | 0.018        | 0.030 |
| $\alpha$ | 0°          | 8°   | 0°           | 8°    |
| aaa      | -           | 0.10 | -            | 0.004 |





## Ordering Information

| Part / Order Number | Marking      | Shipping packaging | Package     | Temperature |
|---------------------|--------------|--------------------|-------------|-------------|
| MK1709S             | (see page 7) | Tubes              | 8-pin SOIC  | 0 to +85° C |
| MK1709STR           |              | Tape and Reel      | 8-pin SOIC  | 0 to +85° C |
| MK1709AG            |              | Tubes              | 8-pin TSSOP | 0 to +85° C |
| MK1709AGTR          |              | Tape and Reel      | 8-pin TSSOP | 0 to +85° C |
| MK1709AGLF          |              | Tubes              | 8-pin TSSOP | 0 to +85° C |
| MK1709AGLFTR        |              | Tape and Reel      | 8-pin TSSOP | 0 to +85° C |

**Parts that are ordered with a "LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.**

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