

# OSCILLATOR, MULTIPLIER, AND BUFFER WITH 8 OUTPUTS

## ICS552A-01

### Description

The ICS552A-01 produces 8 low-skew copies of the multiple input clock or fundamental, parallel-mode crystal. Unlike other clock drivers, these parts do not require a separate oscillator for the input. Using IDT's patented Phase-Locked Loop (PLL) to multiply the input frequency, it is ideal for generating and distributing multiple high-frequency clocks. **This is a single chip used for 3 different applications:**

1) ICS552A-01 (A mode) — an Oscillator multiplier

2) ICS552A-01 (B mode) — a Dual 1:4 buffer

3) ICS552A-01 (C mode) — a 1:8 Oscillator buffer

### Features (all)

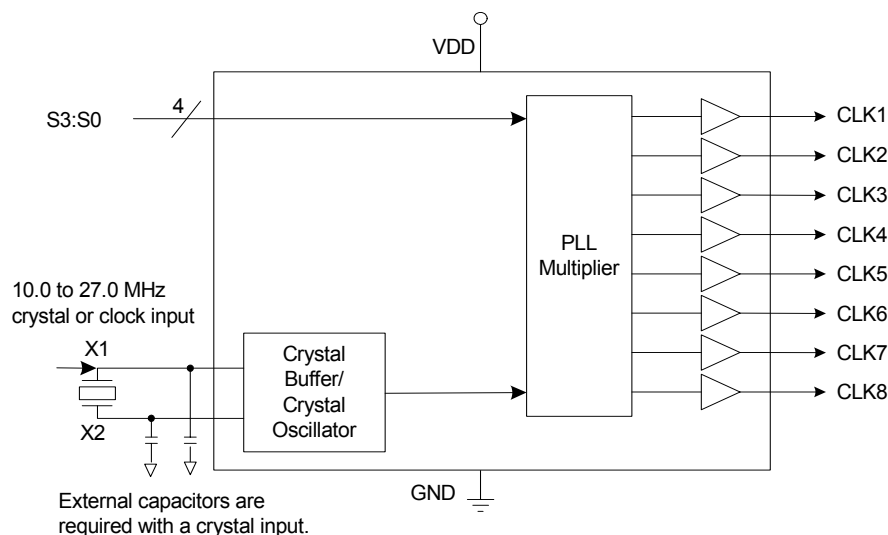
- Packaged as 20-pin SSOP (QSOP)
- Pb-free packaging available
- Operating voltages of 3.0 V to 5.5 V
- Industrial temperature available

### Features (specific)

#### ICS552A-01 (for A mode)

- Contains on-chip multiplier with selections of x1, x1.33, x2, x2.66, x3, x3.33, x4, x4.66, x5, and x6

### Block Diagram (ICS552A-01—A mode)



- Power-down and Tri-state modes

#### ICS552A-01 (for B mode)

- Up to 200 MHz clock input/output at 3.3 V
- Low skew of 250 ps maximum for any bank of four
- Inputs can be connected together for a 1 to 8 buffer with 250 ps skew between any outputs
- Non-inverting buffer mode
- Ideal for clock networks
- Output Enable mode tri-states outputs
- Full CMOS output swing with 25 mA output drive capability at TTL levels
- Advanced, low power, sub-micron CMOS process

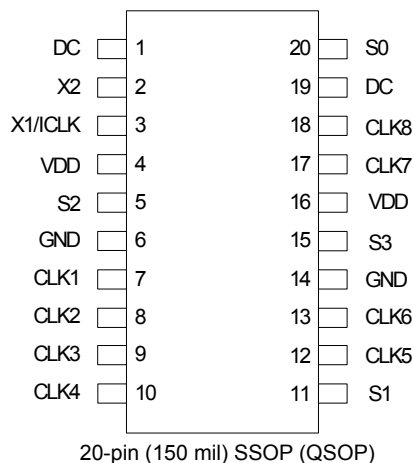
#### ICS552A-01 (for C mode)

- Use with 25 MHz crystal for networking
- Use with 27 MHz crystal for MPEG

#### ICS552A-01 (for A and C modes)

- Input frequency of 10.0 to 27.0 MHz
- Provides 8 low-skew outputs (<250 ps)
- Output clock duty cycle of 40/60 at 3.3 V

## Pin Assignment (ICS552A-01—A mode)



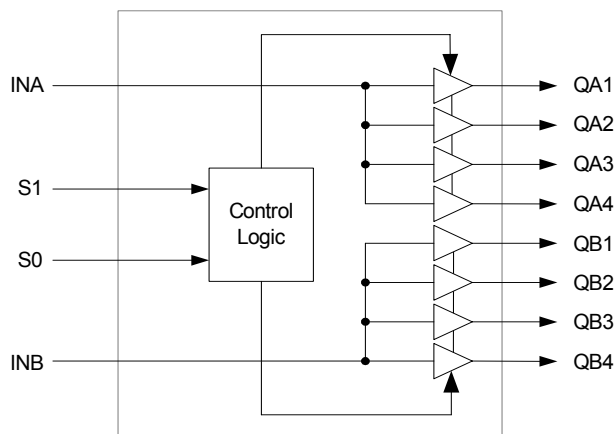
## Multiplier Select Table

| S3 | S2 | S1 | S0 | Multiplier    |
|----|----|----|----|---------------|
| 0  | 0  | 0  | 0  | Power Down    |
| 0  | 0  | 0  | 1  | x1            |
| 0  | 0  | 1  | 0  | x1.333        |
| 0  | 0  | 1  | 1  | x2            |
| 0  | 1  | 0  | 0  | x2.666        |
| 0  | 1  | 0  | 1  | x3            |
| 0  | 1  | 1  | 0  | x3.333        |
| 0  | 1  | 1  | 1  | x4            |
| 1  | 0  | 0  | 0  | x5            |
| 1  | 0  | 0  | 1  | x4.66         |
| 1  | 0  | 1  | 0  | x6            |
| 1  | 1  | 0  | 1  | Tri-state all |

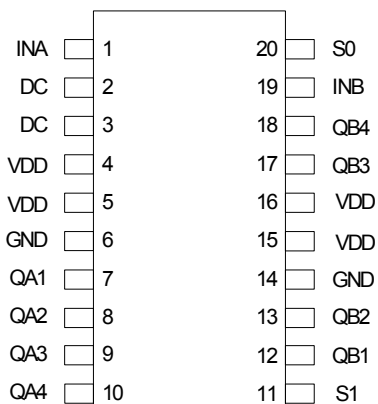
## Pin Descriptions (ICS552A-01—A mode)

| Pin Number | Pin Name | Pin Type | Pin Description                                                                 |
|------------|----------|----------|---------------------------------------------------------------------------------|
| 1          | DC       | —        | Do not connect.                                                                 |
| 2          | X2       | XO       | Crystal connection. Connect to a 10 - 27 MHz fundamental mode crystal.          |
| 3          | X1/ICLK  | XI       | Crystal connection. Connect to a 10 - 27 MHz fundamental mode crystal or clock. |
| 4          | VDD      | Power    | Connect to +3.3 V or 5 V. Decouple with pin 6. Must be same as other VDDs.      |
| 5          | S2       | Input    | Multiplier Select pin 2 per table above.                                        |
| 6          | GND      | Power    | Connect to ground.                                                              |
| 7          | CLK1     | Output   | Output clock 1.                                                                 |
| 8          | CLK2     | Output   | Output clock 2.                                                                 |
| 9          | CLK3     | Output   | Output clock 3.                                                                 |
| 10         | CLK4     | Output   | Output clock 4.                                                                 |
| 11         | S1       | Input    | Multiplier Select pin 1 per table above                                         |
| 12         | CLK5     | Output   | Output clock 5.                                                                 |
| 13         | CLK6     | Output   | Output clock 6.                                                                 |
| 14         | GND      | Power    | Connect to ground.                                                              |
| 15         | S3       | Input    | Multiplier Select pin 3 per table above                                         |
| 16         | VDD      | Power    | Connect to +3.3 V or 5 V. Decouple with pin 14. Must be same as other VDDs.     |
| 17         | CLK7     | Output   | Output clock 7.                                                                 |
| 18         | CLK8     | Output   | Output clock 8.                                                                 |
| 19         | DC       | —        | Do not connect.                                                                 |
| 20         | S0       | Input    | Multiplier Select pin 0 per table above                                         |

## Block Diagram (ICS552A-01—B mode)



## Pin Assignment (ICS552A-01—B mode)



20-pin (150 mil) SSOP (QSOP)

## Clock Output Select Table (ICS552A-01—B mode)

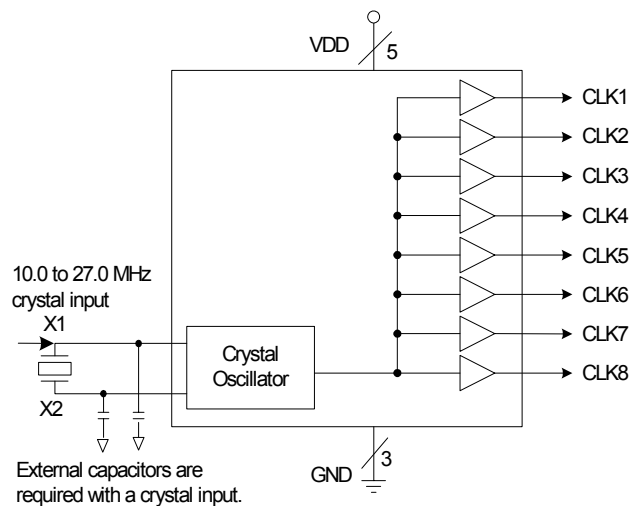
| S1 | S0 | Mode                              |
|----|----|-----------------------------------|
| 0  | 0  | QA1:4 and QB1:4 running           |
| 0  | 1  | Test mode                         |
| 1  | 0  | OE. All outputs in high impedance |
| 1  | 1  | QA1:4 only. QB1:4 stopped low     |

## Pin Descriptions (ICS552A-01—B mode)

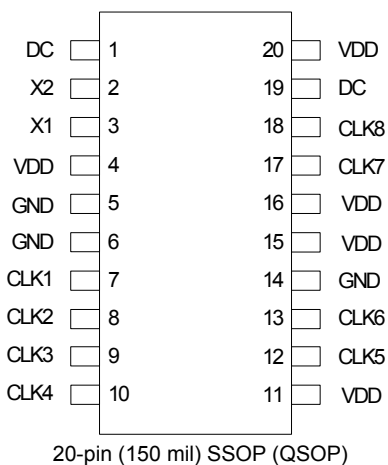
| Pin Number | Pin Name | Pin Type | Pin Description                                                                                           |
|------------|----------|----------|-----------------------------------------------------------------------------------------------------------|
| 1          | INA      | CI       | Input to buffer A. Outputs QA1:4 will be the same frequency. Internal pull-up resistor.                   |
| 2          | DC       | —        | Do not connect.                                                                                           |
| 3          | DC       | —        | Do not connect.                                                                                           |
| 4          | VDD      | Power    | Connect to +3.3 V or 5.0 V. Must be same as other VDDs.                                                   |
| 5          | VDD      | Power    | Connect to +3.3 V or 5.0 V. Must be same as other VDDs.                                                   |
| 6          | GND      | Power    | Connect to ground.                                                                                        |
| 7          | QA1      | Output   | Output 1 from buffer A.                                                                                   |
| 8          | QA2      | Output   | Output 2 from buffer A.                                                                                   |
| 9          | QA3      | Output   | Output 3 from buffer A.                                                                                   |
| 10         | QA4      | Output   | Output 4 from buffer A.                                                                                   |
| 11         | S1       | I        | Mode Select pin 1. Selects mode for outputs. Must be at GND for all clocks on. Internal pull-up resistor. |
| 12         | QB1      | Output   | Output 1 from buffer B.                                                                                   |
| 13         | QB2      | Output   | Output 2 from buffer B.                                                                                   |
| 14         | GND      | Power    | Connect to ground.                                                                                        |
| 15         | VDD      | Power    | Connect to +3.3 V or 5.0 V. Must be same as other VDDs.                                                   |
| 16         | VDD      | Power    | Connect to +3.3 V or 5.0 V. Must be same as other VDDs.                                                   |
| 17         | QB3      | Output   | Output 3 from buffer B.                                                                                   |
| 18         | QB4      | Output   | Output 4 from buffer B.                                                                                   |
| 19         | INB      | CI       | Input to buffer B. Outputs QA1:4 will be the same frequency. Internal pull-up resistor.                   |
| 20         | S0       | I        | Mode Select pin 0. Selects mode for outputs. Must be at GND for all clocks on. Internal pull-up resistor. |

KEY: CI = clock input with pull-up resistor; I = input with internal pull-up resistor.

## Block Diagram (ICS552A-01—C mode)



## Pin Assignment (ICS552A-01—C mode)



**Pin Descriptions (ICS552A-01—C mode)**

| Pin Number | Pin Name | Pin Type | Pin Description                                                             |
|------------|----------|----------|-----------------------------------------------------------------------------|
| 1          | DC       | —        | Do not connect.                                                             |
| 2          | X2       | XO       | Crystal connection. Connect to a 10 - 27 MHz fundamental mode crystal.      |
| 3          | X1       | XI       | Crystal connection. Connect to a 10 - 27 MHz fundamental mode crystal.      |
| 4          | VDD      | Power    | Connect to +3.3 V or 5 V. Decouple with pin 6. Must be same as other VDDs.  |
| 5          | GND      | Power    | Connect to ground.                                                          |
| 6          | GND      | Power    | Connect to ground.                                                          |
| 7          | CLK1     | Output   | Output clock 1.                                                             |
| 8          | CLK2     | Output   | Output clock 2.                                                             |
| 9          | CLK3     | Output   | Output clock 3.                                                             |
| 10         | CLK4     | Output   | Output clock 4.                                                             |
| 11         | VDD      | Power    | Connect to +3.3 V or 5 V. Must be same as other VDDs.                       |
| 12         | CLK5     | Output   | Output clock 5.                                                             |
| 13         | CLK6     | Output   | Output clock 6.                                                             |
| 14         | GND      | Power    | Connect to ground.                                                          |
| 15         | VDD      | Power    | Connect to +3.3 V or 5 V. Must be same as other VDDs.                       |
| 16         | VDD      | Power    | Connect to +3.3 V or 5 V. Decouple with pin 14. Must be same as other VDDs. |
| 17         | CLK7     | Output   | Output clock 7.                                                             |
| 18         | CLK8     | Output   | Output clock 8.                                                             |
| 19         | DC       | —        | Do not connect.                                                             |
| 20         | VDD      | Power    | Connect to +3.3 V or 5 V. Must be same as other VDDs.                       |

## External Components

### Series Termination Resistor

Clock output traces over one inch should use series termination. To series terminate a 50Ω trace (a commonly used trace impedance), place a 33Ω resistor in series with the clock line, as close to the clock output pin as possible. The nominal impedance of the clock output is 20Ω.

### Decoupling Capacitors

As with any high-performance mixed-signal IC, the ICS552A-01 must be isolated from system power supply noise to perform optimally.

Decoupling capacitors of 0.01μF must be connected between each VDD and GND on pins 4 and 6, and 16 and 14. Other VDDs and GNDs can be connected to these pins or directly to their respective ground planes.

### Crystal Load Capacitors

The device crystal connections should include pads for small capacitors from X1 to ground and from X2 to ground. These capacitors are used to adjust the stray capacitance of the board to match the nominally required crystal load capacitance. Because load capacitance can only be increased in this trimming process, it is important to keep stray capacitance to a minimum by using very short PCB traces (and no vias) between the crystal and device. Crystal capacitors must be connected from each of the pins X1 and X2 to ground.

The value (in pF) of these crystal caps should equal  $(C_L - 12 \text{ pF}) \times 2$ . In this equation,  $C_L$  = crystal load capacitance in pF. Example: For a crystal with a 18 pF load capacitance, two 12 pF capacitors should be used. For a clock input, connect it X1/ICLK and leave X2 unconnected (floating).

## PCB Layout Recommendations

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

- 1) Each 0.01μF 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 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) The external crystal should be mounted just next to the device with short traces. The X1 and X2 traces should not be routed next to each other with minimum spaces, instead they should be separated and away from other traces.
- 3) To minimize EMI, the 33Ω series termination resistor (if needed) should be placed close to the clock output.
- 4) An optimum layout is one with all components on the same side of the board, minimizing vias through other signal layers.

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS552A-01. These ratings, which are standard values for IDT 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.

| Parameter             | Condition         | Min. | Typ. | Max.    | Units |
|-----------------------|-------------------|------|------|---------|-------|
| Supply Voltage, VDD   | Referenced to GND |      |      | 7       | V     |
| Inputs                | Referenced to GND | -0.5 |      | VDD+0.5 | V     |
| Clock Outputs         | Referenced to GND | -0.5 |      | VDD+0.5 | V     |
| Storage Temperature   |                   | -65  |      | 150     | °C    |
| Soldering Temperature | Max 10 seconds    |      |      | 260     | °C    |
| Junction Temperature  |                   |      |      | 125     | °C    |

## Recommended Operation Conditions

| Parameter                                  | Min. | Typ. | Max. | Units |
|--------------------------------------------|------|------|------|-------|
| Ambient Operating Temperature (commercial) | 0    |      | +70  | °C    |
| Ambient Operating Temperature (industrial) | -40  |      | +85  | °C    |

## DC Electrical Characteristics

Unless stated otherwise, **VDD = 3.3 V or 5 V**, Ambient Temperature -40 to +85°C

| Parameter             | Symbol          | Conditions                                     | Min.    | Typ.  | Max.    | Units |
|-----------------------|-----------------|------------------------------------------------|---------|-------|---------|-------|
| Operating Voltage     | VDD             |                                                | 3.0     |       | 5.5     | V     |
| Input High Voltage    | V <sub>IH</sub> | ICLK                                           | VDD/2+1 | VDD/2 |         | V     |
| Input Low Voltage     | V <sub>IL</sub> | ICLK                                           |         | VDD/2 | VDD/2-1 | V     |
| Input High Voltage    | V <sub>IH</sub> | S3:S0                                          | 2       |       |         | V     |
| Input Low Voltage     | V <sub>IL</sub> | S3:S0                                          |         |       | 0.8     | V     |
| Output High Voltage   | V <sub>OH</sub> | VDD = 3.3 V,<br>I <sub>OH</sub> = -8 mA        | 2.4     |       |         | V     |
| Output Low Voltage    | V <sub>OL</sub> | VDD = 3.3 V,<br>I <sub>OL</sub> = 8 mA         |         |       | 0.4     | V     |
| Output High Voltage   | V <sub>OH</sub> | VDD = 3.3 V or 5 V,<br>I <sub>OH</sub> = -8 mA | VDD-0.4 |       |         | V     |
| Short Circuit Current | I <sub>OS</sub> | VDD = 3.3 V, each output                       |         | ±50   |         | mA    |



| Parameter                 | Symbol   | Conditions                       | Min. | Typ. | Max. | Units   |
|---------------------------|----------|----------------------------------|------|------|------|---------|
| Operating Supply Current  | $I_{DD}$ | at 3.3 V, no load, 25 MHz in, x4 |      | 35   |      | mA      |
| Operating Supply Current  | $I_{DD}$ | at 5 V, no load, 25 MHz in, x4   |      | 59   |      | mA      |
| Power-down Supply Current | $I_{DD}$ | S3:S0 = 0 (GND)                  |      | 55   |      | $\mu$ A |

## AC Electrical Characteristics

Unless stated otherwise, **VDD = 3.3 V or 5 V**, Ambient Temperature -40 to +85° C

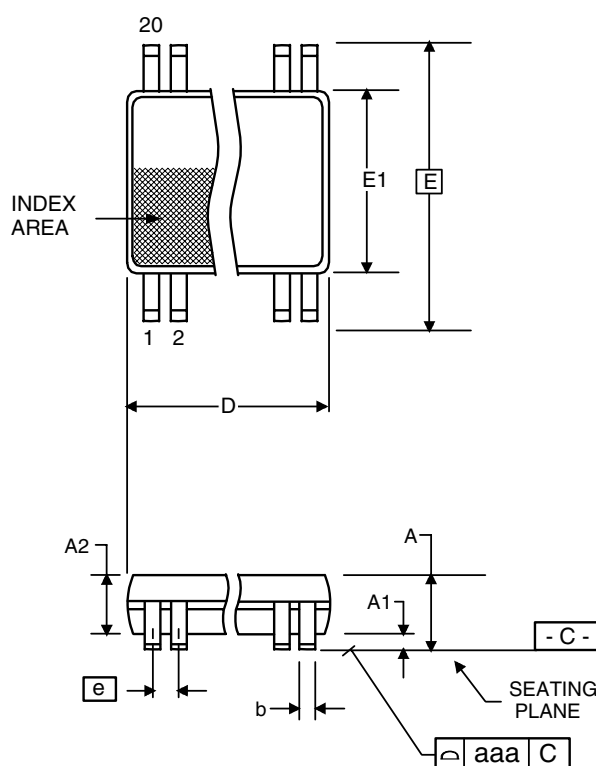
| Parameter                     | Symbol   | Conditions                       | Min. | Typ.     | Max. | Units |
|-------------------------------|----------|----------------------------------|------|----------|------|-------|
| Input Frequency               | $F_{IN}$ | Fundamental crystal              | 10   |          | 27   | MHz   |
|                               |          | Input clock–non-buffer mode      | 10   |          | 27   | MHz   |
|                               |          | Input clock–buffer mode only     | 10   |          | 200  | MHz   |
| Output Rise Time              | $t_{OR}$ | 0.8 to 2.0 V                     |      |          | 1.5  | ns    |
| Output Fall Time              | $t_{OF}$ | 2.0 to 0.8 V                     |      |          | 1.5  | ns    |
| Duty Cycle                    |          | at VDD/2                         | 40   | 50       | 60   | %     |
| Output-to-Output Skew         |          | All modes, Rising edges at VDD/2 |      |          | 250  | ps    |
| Absolute Jitter               |          | Mode A, Deviation from Mean      |      | $\pm 75$ |      | ps    |
| One Sigma Clock Period Jitter |          | Mode A                           |      | 25       |      | ps    |

## Thermal Characteristics

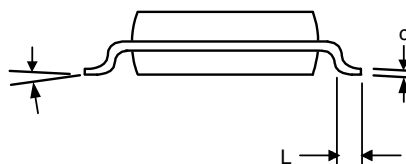
| Parameter                              | Symbol        | Conditions     | Min. | Typ. | Max. | Units |
|----------------------------------------|---------------|----------------|------|------|------|-------|
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | Still air      |      | 135  |      | °C/W  |
|                                        | $\theta_{JA}$ | 1 m/s air flow |      | 93   |      | °C/W  |
|                                        | $\theta_{JA}$ | 3 m/s air flow |      | 78   |      | °C/W  |
| Thermal Resistance Junction to Case    | $\theta_{JC}$ |                |      | 60   |      | °C/W  |

## Package Outline and Package Dimensions (20-pin SSOP, 150 Mil. Wide Body)

Package dimensions are kept current with JEDEC Publication No. 95



|          | Millimeters |      | Inches     |       |
|----------|-------------|------|------------|-------|
| Symbol   | Min         | Max  | Min        | Max   |
| A        | 1.35        | 1.75 | 0.053      | 0.069 |
| A1       | 0.10        | 0.25 | 0.004      | 0.010 |
| A2       | --          | 1.50 | --         | 0.059 |
| b        | 0.20        | 0.30 | 0.008      | 0.012 |
| c        | 0.18        | 0.25 | 0.007      | 0.010 |
| D        | 8.55        | 8.75 | 0.337      | 0.344 |
| E        | 5.80        | 6.20 | 0.228      | 0.244 |
| E1       | 3.80        | 4.00 | 0.150      | 0.157 |
| e        | .635 Basic  |      | .025 Basic |       |
| L        | 0.40        | 1.27 | 0.016      | 0.050 |
| $\alpha$ | 0°          | 8°   | 0°         | 8°    |
| aaa      | --          | 0.10 | --         | 0.004 |



## Ordering Information

| Part / Order Number | Marking    | Shipping Packaging | Package     | Temperature   |
|---------------------|------------|--------------------|-------------|---------------|
| 552AR-01LF          | 552AR-01LF | Tubes              | 20-pin SSOP | 0 to +70° C   |
| 552AR-01LFT         | 552AR-01LF | Tape and Reel      | 20-pin SSOP | 0 to +70° C   |
| 552ARI-01LF         | 552ARI01LF | Tubes              | 20-pin SSOP | -40 to +85° C |
| 552ARI-01LFT        | 552ARI01LF | Tape and Reel      | 20-pin SSOP | -40 to +85° C |

**"LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.**

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