

## Dual Channel Function/Arbitrary Waveform Generators 4050B Series



The 4050B Series Dual Channel Function/Arbitrary Waveform Generators are capable of generating stable and precise sine, square, triangle, pulse, and arbitrary waveforms. With an easy-to-read color display and intuitive user interface with numeric keypad, these instruments offer plenty of features including linear/logarithmic sweep, built-in counter, extensive modulation and triggering capabilities, a continuously variable DC offset, and a high performance 14-bit, 150 MSa/s arbitrary waveform generator. CH1 and CH2 outputs can both be varied from 0 to 10 Vpp into 50 ohms (up to 20 Vpp into open circuit).

Easily create custom arbitrary waveforms using the included waveform editing software or use any of the 196 built-in predefined arbitrary waveforms. More than 1000 user-defined 16k point arbitrary waveforms can be saved to the instrument. Additionally, the included LabVIEW™ drivers allow users to conveniently load and save .csv or .txt file data directly into the arb memory without having to use waveform editing software.

Extensive modulation capabilities include amplitude and frequency modulation (AM/FM), double sideband amplitude modulation (DSB AM), amplitude and frequency shift keying (ASK/FSK), phase modulation (PM), phase shift keying (PSK), and pulse width modulation (PWM).

The standard external 10 MHz reference clock input and output allows users to synchronize their instrument with another generator. Additionally, the generators offer powerful channel copy, track and combine functionality and the phase of both output channels can be synchronized conveniently with the push of a button. These handy features are typically not found in function generators at this price point.

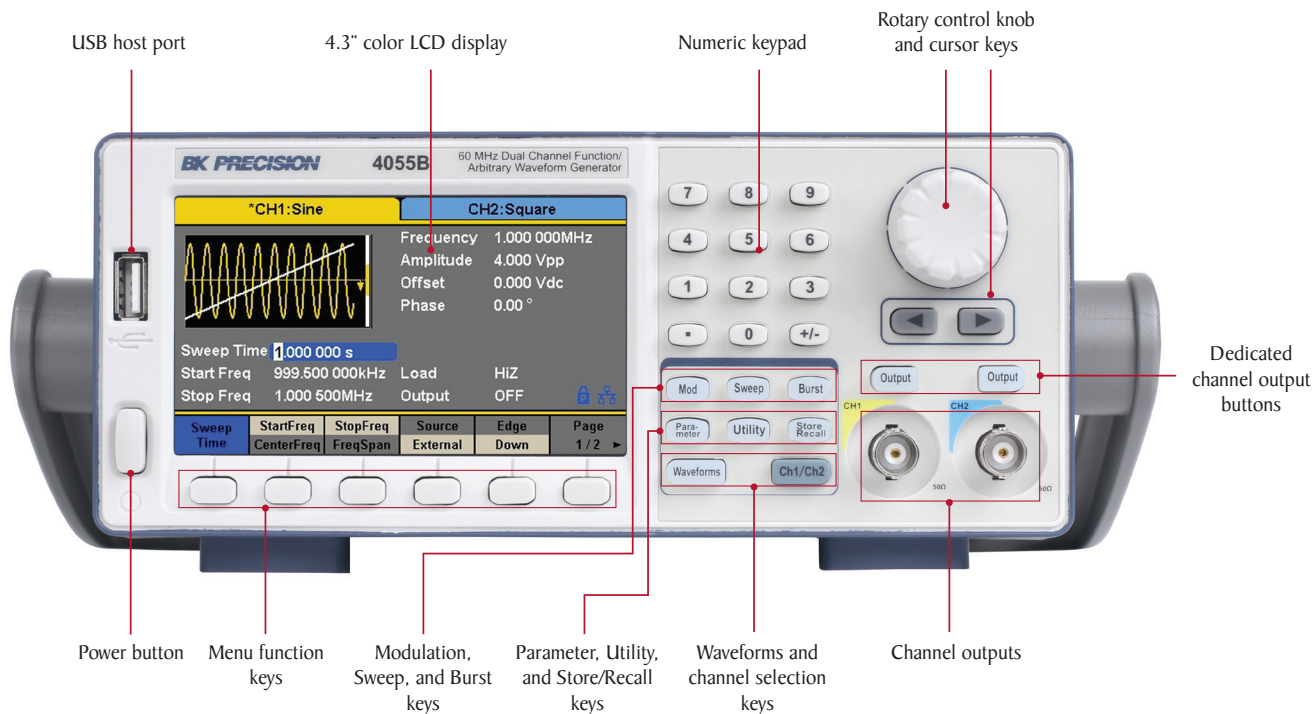
These versatile function/arbitrary waveform generators are suitable for education and other applications that require high signal fidelity, a variety of modulation schemes, or arbitrary waveform generation capabilities.

### Features & Benefits

- 14-bit, 150 MSa/s, 16k point arbitrary waveform generator
- Two independent channels with individual output On/Off buttons
- Convenient channel copy, track and combine functions
- Synchronize the phase of both channels with the push of a button
- Low-jitter square wave generation for simulating reliable clock signals, generating triggers, or validating serial data buses
- Large 4.3-inch LCD color display
- Linear and logarithmic sweep
- AM/DSB-AM/ASK/FM/FSK/PM/PSK/PWM modulation functions
- Variable DC offset
- Adjustable duty cycle
- Internal/external triggering
- Gate and burst mode
- 196 built-in predefined arbitrary waveforms
- Flash memory size of approximately 100 MB allows for storage/recall of >1000 instrument settings and user-defined arbitrary waveforms
- Built-in frequency counter
- Harmonics generator function
- LAN, USB device port (USBTMC-compliant), and front panel USB host port
- GPIB connectivity with optional USB-to-GPIB adapter
- PC software provided for arbitrary waveform editing
- Short circuit output protection

| Model                           | 4053B               | 4054B               | 4055B               |
|---------------------------------|---------------------|---------------------|---------------------|
| Sine and square frequency range | 1 $\mu$ Hz – 10 MHz | 1 $\mu$ Hz – 30 MHz | 1 $\mu$ Hz – 60 MHz |

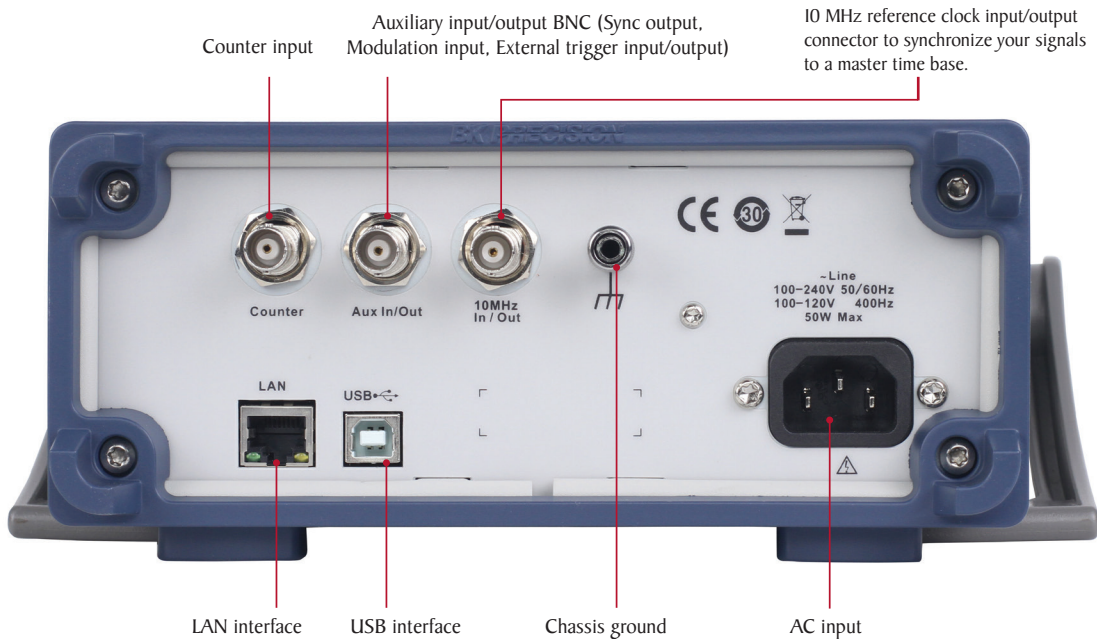
## Front panel



### Intuitive user interface

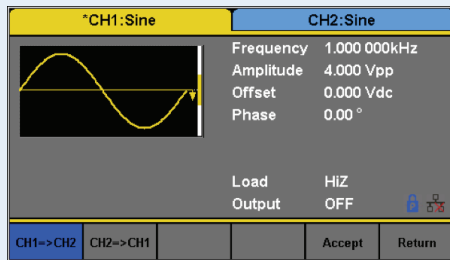
Easily adjust all waveform parameters using the intuitive menu-driven front panel keypad with dedicated channel selection keys, numeric keypad, and rotary control knob. Connect your USB flash drive to the USB host port to quickly save and recall instrument settings and waveforms.

## Rear panel



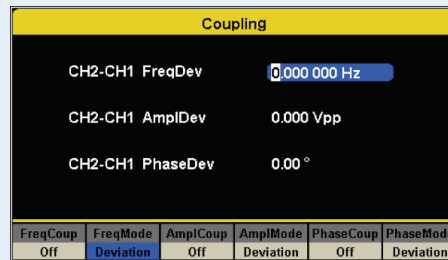
## Flexible operation

### Channel copy and sync function



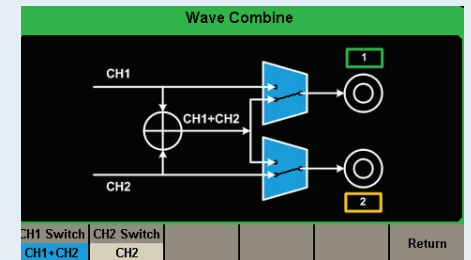
Save time with the 4050B Series' two independent channels to output synchronous signals. With a push of a button, all waveform parameters can be quickly copied between channels to set up identical output signals. Phase between channels can also be adjusted from the front panel.

### Channel tracking function



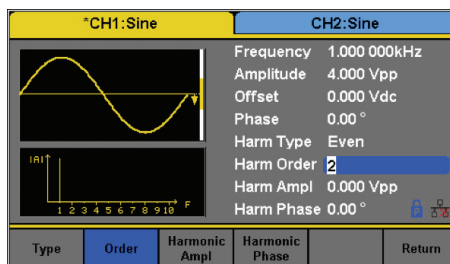
Customize your generator's channel output configuration with frequency, amplitude, and phase coupling. When enabled, CH1 and CH2 can automatically track according to the user's set frequency, amplitude, and phase deviation ratio between channels.

### Channel combine function



Create complex waveforms by internally adding each channel's waveform and outputting the combined waveform on channel 1 or 2.

### Harmonics function



Generate harmonics up to the 10th order with independent amplitude and phase settings.

### Advanced square and pulse generator

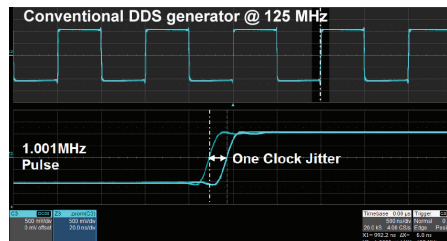


Fig 1

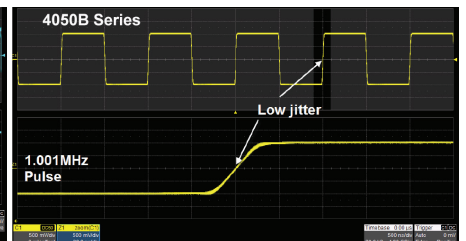


Fig 2

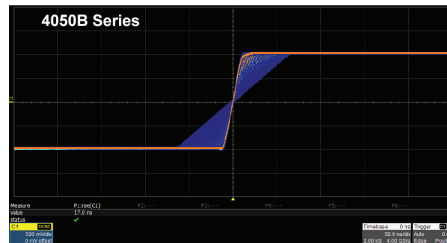


Fig 3

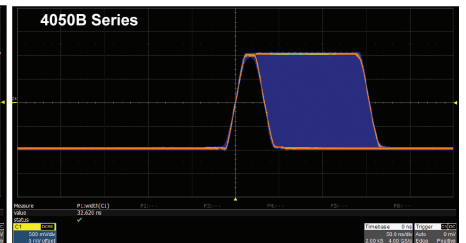
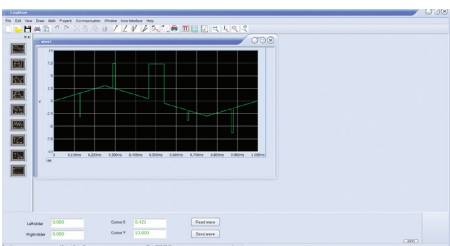


Fig 4

### Generate arbitrary waveforms with ease



The 4050B Series features a large, non-volatile flash memory of about 100 MB, allowing users to create, store, and recall >1000 user-defined 16k point arbitrary waveforms or output any of the 196 built-in predefined arbitrary waveforms.

The provided waveform editing software can be used to create point-by-point arbitrary waveforms via freehand or waveform math functions. A standard USB interface on the rear panel allows users to easily interface with a PC to load these arbitrary waveforms into the instrument. The front panel also offers a convenient USB host port for connecting your USB flash drive to save/recall instrument settings and waveforms.

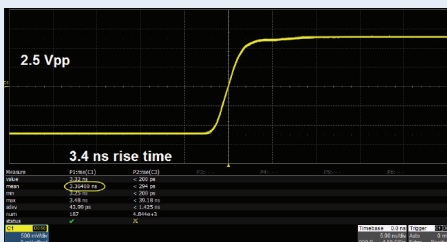


Fig 5



Fig 6

Generate high performance square waves with < 3.4 ns rise/fall times (Fig 5) and rms jitter < 300ps + 0.05 ppm of period (Fig 6)

## Specifications

| Model  | 4053B  | 4054B               | 4055B               |
|--|--|---------------------|---------------------|
| Channels   | 2  |                     |                     |
| <b>Frequency Characteristics</b>                               |  |                     |                     |
| Sine & Square  | 1 $\mu$ Hz – 10 MHz  | 1 $\mu$ Hz – 30 MHz | 1 $\mu$ Hz – 60 MHz |
| Triangle, Ramp   | 1 $\mu$ Hz – 500 kHz   |                     |                     |
| Pulse  | 1 $\mu$ Hz – 12.5 MHz  |                     |                     |
| Noise (-3 dB)  | > 60 MHz   |                     |                     |
| Arbitrary  | 1 $\mu$ Hz – 6 MHz   |                     |                     |
| Accuracy   | $\pm$ 25 ppm (1 year)  |                     |                     |
| Resolution   | 1 $\mu$ Hz   |                     |                     |
| <b>Arbitrary Characteristics</b>                               |  |                     |                     |
| Built-in Waveforms   | 196 built-in waveforms (includes DC)   |                     |                     |
| Waveform Length  | 16k points / Ch  |                     |                     |
| Vertical Resolution  | 14 bits  |                     |                     |
| Sampling Rate  | 150 MSa/s  |                     |                     |
| Minimum Rise/Fall Time   | 6.5 ns (typical)   |                     |                     |
| Jitter (pk-pk)   | 8 ns (typical)   |                     |                     |
| Non-volatile Memory Storage                                    | > 1000 16k points waveforms (100 MB in file system)  |                     |                     |
| <b>Output Characteristics</b>                                  |  |                     |                     |
| Amplitude Range  | 2 mVpp – 10 Vpp into 50 $\Omega$ (4 mVpp – 20 Vpp into open circuit), $\leq$ 10 MHz<br>2 mVpp – 5 Vpp into 50 $\Omega$ (4 mVpp – 10 Vpp into open circuit), > 10 MHz |                     |                     |
| Amplitude Resolution   | up to 4 digits   |                     |                     |
| Amplitude Accuracy (10 kHz)                                    | $\pm$ (1% + 1 mVpp)  |                     |                     |
| Amplitude Flatness   | $\pm$ 0.3 dB (reference 10 kHz, 2.5 Vpp, 50 $\Omega$ load)   |                     |                     |
| Cross Talk   | < -60 dBc (both channels set to 0 dBm, sine 50 $\Omega$ load)  |                     |                     |
| Offset Range (DC)  | $\pm$ 5 V into 50 $\Omega$ ( $\pm$ 10 V into open circuit)   |                     |                     |
| Offset Resolution  | up to 4 digits   |                     |                     |
| Offset Accuracy  | $\pm$ (offset setting value $\times$ 1% + 3 mV)  |                     |                     |
| Channel Output Impedance                                       | 50 $\Omega$ , high impedance   |                     |                     |
| Output Protection  | short-circuit protection   |                     |                     |
| <b>Waveform Characteristics (sine, square, triangle, ramp)</b> |  |                     |                     |
| Harmonic Distortion (Sine)                                     | DC – 10 MHz, < -60 dBc / 10 MHz – 30 MHz < -50 dBc / 30 MHz – 60 MHz, < -40 dBc (0 dBm input signal)   |                     |                     |
| Total Harmonic Distortion (Sine)                               | 10 Hz – 20 kHz at 0 dBm, < 0.075%  |                     |                     |
| Spurious (non-harmonic)  | DC – 10 MHz, < -65 dBc / 10 MHz – 30 MHz, < -55 / 30 MHz – 60 MHz, < -40 (0 dBm input signal)  |                     |                     |
| Rise/Fall Time (square)  | < 4.2 ns (10% – 90%, at 1Vpp into 50 $\Omega$ )  |                     |                     |
| Variable Duty Cycle (square)                                   | 0.001% - 99.999% (depending on frequency setting)  |                     |                     |
| Asymmetry (50% duty cycle)                                     | 1% of period + 20 ns (typical, 1 kHz, 1 Vpp)   |                     |                     |
| Jitter (rms) cycle to cycle (square)                           | 300 ps + 0.00 ppm of period (typical, 1 kHz, 1 Vpp)  |                     |                     |
| Ramp Symmetry  | 0% – 100%  |                     |                     |
| Linearity (triangle, ramp at 1 kHz, 1 Vpp, 100% symmetry)      | < 1% of peak output (typical)  |                     |                     |

## Dual Channel Function/Arbitrary Waveform Generators 4050B Series

| Model   | 4053B, 4054B & 4055B                                  |
|---|---|
| <b>Pulse</b>                                      |   |
| Pulse Width                                       | 32.6 ns minimum, 100 ps resolution, 1,000,000 s max.  |
| Rise/Fall Time                                    | 16.8 ns ( 1 Vpp, 50 10% – 90% 50 Ω load)              |
| Duty Cycle  | 0.001% resolution                                     |
| Overshoot   | < 3 % (100 kHz, 1 Vpp)                                |
| Jitter (rms) cycle to cycle                       | 300 ps + 0.05 ppm of period (typical, 1 kHz, 1 Vpp)   |
| <b>Burst</b>                                      |   |
| Waveform  | sine, square, ramp, pulse, arbitrary, noise           |
| Type  | cycle (1-1000000 cycles), infinite, gated             |
| Start/Stop Phase                                  | 0 ° – 360 °   |
| Internal Period                                   | 1 μs – 1000 s   |
| Gated Source                                      | Internal, external trigger                            |
| Trigger Source                                    | internal, external, manual                            |
| <b>Phase Offset</b>                               |   |
| Range   | 0 ° – 360 °   |
| Resolution  | 0.1 °   |
| <b>AM, FM &amp; PM Modulation Characteristics</b> |   |
| Carrier   | sine, square, ramp, arbitrary (except DC)             |
| Source  | internal, external                                    |
| Internal Modulation Waveform                      | sine, square, ramp, noise, arbitrary (1 MHz – 20 kHz) |
| AM Modulation Depth                               | 0% – 120%, 0.1% resolution                            |
| FM Frequency Deviation                            | 0 – 0.5*bandwidth, 10 μHz resolution                  |
| PM Phase Deviation                                | 0 – 360 °, 0.1 ° resolution                           |
| <b>ASK &amp; FSK Modulation Characteristics</b>   |   |
| Carrier   | sine, square, ramp, arbitrary (except DC)             |
| Source  | internal, external                                    |
| Modulation Waveform                               | 50% duty cycle square waveform (1 MHz – 50 kHz)       |
| <b>PWM Modulation Characteristics</b>             |   |
| Source  | internal, external                                    |
| Modulation Waveform                               | sine, square, ramp, arbitrary (except DC)             |
| Internal Modulation Frequency                     | 1 MHz – 20 kHz  |
| <b>DSB-AM Modulation Characteristics</b>          |   |
| Carrier   | sine, square, ramp, arbitrary (except DC)             |
| Source  | internal, external                                    |
| Modulation Waveform                               | sine, square, ramp, noise, arbitrary (1 MHz – 20 kHz) |
| <b>Sweep Characteristics</b>                      |   |
| Waveforms   | sine, square, ramp, arbitrary (except DC)             |
| Sweep Shape                                       | linear or logarithmic, up or down                     |
| Sweep Time  | 1 ms – 500 s  |
| Sweep Trigger                                     | internal, external, manual                            |

|                                 |   |
|---------------------------------|---|
| <b>Auxiliary Input / Output</b> |   |
| Modulation Input                | ±6 Vpp (typical) for 100% modulation<br>Maximum input voltage: 7 V<br>Input impedance: 10 kΩ  |
| Sync and Trigger Out            | TTL compatible *1)<br>Output impedance 100 Ω<br>Maximum frequency: 1 MHz<br>Minimum pulse width: 500 ns   |
| Trigger In                      | TTL compatible *2)<br>Input impedance: 10 kΩ<br>Minimum pulse width: 100 ns<br>Response time 100 ns (max) in sweep mode and<br>600 ns (max) in burst mode                                     |
| <b>Reference Clock</b>          |   |
| Input                           | Frequency Range: 10 MHz ± 1 kHz (typical)<br>Min. Voltage Input: 1.4 V<br>5 kΩ input impedance  |
| Output                          | Frequency Range: 10 MHz ± 25 ppm (typical)<br>Voltage Level: 3.3 V (typical), 2 V (minimum)<br>50 Ω output impedance  |
| <b>Frequency Counter</b>        |   |
| Measurement                     | frequency, period, duty cycle,<br>positive/negative pulse width   |
| Measurement Range               | 100 mHz – 200 MHz (DC coupling)<br>10 Hz – 200 MHz (AC coupling)  |
| Input Range                     | 100 mV to ± 2.5 V (< 100 MHz, DC coupling)<br>200 mV to ± 2.5 V (100 MHz – 200 MHz, DC coupling)<br>100 mV to 5 V (< 100 MHz, AC coupling)<br>200 mV to 5 V ( 100 MHz – 200 MHz, AC coupling) |
| Input Impedance                 | 1 MΩ  |
| Coupling                        | AC, DC, HF, REJ   |
| <b>Environmental and Safety</b> |   |
| Temperature                     | operating: 32 °F – 104 °F (0 °C – 40 °C)<br>storage: -4 °F – 140 °F (-20 °C – 60 °C)  |
| Humidity                        | < 86° F (30 °C), ≤ 90 % RH<br>104 °F (40 °C), ≤ 50 % RH   |
| Altitude                        | operating: below 9,842 ft (3,000 m)<br>storage: below 49,212 ft (15,000 m)  |
| Electromagnetic Compatibility   | EMC Directive 2004/108/EC, EN61326:2006,<br>EN61000-3-2:2006+A2:2009, EN61000-3-3:2008  |
| Safety                          | Low voltage directive 2006/95/EC, EN61010-1:2001,<br>EN61010-031:2002+A1:2008   |
| <b>General</b>                  |   |
| Display                         | 4.3" TFT-LCD display, 480 x 272   |
| Interfaces                      | LAN & USBTMC (standard), GPIB (optional), USB host port   |
| Storage Memory                  | Arbitrary waveforms and instrument settings share the same non-volatile storage memory of 100 MB.   |
| Power                           | 100 – 240 VAC ± 10%, 50 / 60 Hz<br>100 – 120 VAC ± 10%, 400 Hz  |
| Power Consumption               | 50 W max.   |
| Dimensions (W x H x D)          | 263 x 96 x 295 mm (10.3" x 3.78" x 11.6")   |
| Weight                          | 3.32 kg (7.32 lbs)  |
| <b>Three-Year Warranty</b>      |   |
| Standard Accessories            | Getting started manual, instruction manual (downloadable), AC power cord, USB type A-to-type B cable, certificate of calibration  |
| Optional Accessories            | USB-to-GPIB adapter (model AK40G)   |

1\*)  $V_{OH} = 3.8 \text{ V}$  ( $I_{OH} = -8 \text{ mA}$ ),  $V_{OL} = 0.44 \text{ V}$  ( $I_{OL} = 8 \text{ mA}$ )

2\*)  $V_{IH} = 2 \text{ V (min) / 5.5 V (max)}$ ,  $V_{IL} = -0.5 \text{ V (min) / 0.8 V (max)}$