

# Excel Algorithm for Sun's GHA and Declination

This method is based on simplified solar position formulas suitable for nautical accuracy ( $\pm 1'$  of arc). It's ideal for manual sight reduction or spreadsheet automation.

## Inputs Required

- **Date and Time (UTC)** of observation
- **Julian Date (JD)** or **Julian Century (T)**
- **Longitude (for LHA calculation)**

## Step-by-Step Formulas

### 1. Julian Date (JD)

excel  
$$=367*Y - \text{INT}((7*(Y + \text{INT}((M + 9)/12)))/4) + \text{INT}((275*M)/9) + D + 1721013.5 + \text{UT}/24$$

Where:

- Y = year
- M = month
- D = day
- UT = decimal hours (e.g., 14:30 UTC  $\rightarrow$  14.5)

### 2. Julian Century (T)

excel  
$$=(\text{JD} - 2451545.0)/36525$$

### 3. Geometric Mean Longitude of the Sun (L0)

excel  
$$=L0 = \text{MOD}(280.46646 + T*36000.76983 + T^2*0.0003032, 360)$$

### 4. Mean Anomaly of the Sun (M)

excel  
$$=M = 357.52911 + T*35999.05029 - T^2*0.0001537$$

### 5. Equation of Center (C)

excel  
$$=C = \text{SIN}(\text{RADIANS}(M)) * 1.914602 - \text{SIN}(\text{RADIANS}(2*M)) * 0.004817 + \text{SIN}(\text{RADIANS}(3*M)) * 0.000014$$

## 6. True Longitude ( $\theta$ )

excel

$$=\theta = L0 + C$$

## 7. Apparent Longitude ( $\lambda$ )

excel

$$=\lambda = \theta - 0.00569 - 0.00478 * \text{SIN}(\text{RADIANS}(125.04 - 1934.136 * T))$$

## 8. Obliquity of the Ecliptic ( $\varepsilon$ )

excel

$$=\varepsilon = 23.439291 - 0.0130042 * T$$

## 9. Declination ( $\delta$ )

excel

$$=\text{ASIN}(\text{SIN}(\text{RADIANS}(\varepsilon)) * \text{SIN}(\text{RADIANS}(\lambda)))$$

## 10. Greenwich Mean Sidereal Time (GMST)

excel

$$=\text{GMST} = \text{MOD}(280.46061837 + 360.98564736629 * (\text{JD} - 2451545) + T^2 * 0.000387933 - T^3 / 38710000, 360)$$

## 11. GHA of the Sun

excel

$$=\text{GHA} = \text{MOD}(\text{GMST} - \lambda, 360)$$

## Worked Example

Let's say you observed the Sun on **2025-09-10 at 14:00 UTC**.

### Inputs:

- $Y = 2025, M = 9, D = 10$
- $UT = 14.0$

### Step-by-step (rounded for clarity):

1.  $\text{JD} \approx 2460551.0833$
2.  $T \approx 0.2464$
3.  $L0 \approx 168.736^\circ$
4.  $M \approx 262.991^\circ$
5.  $C \approx -1.015^\circ$

6.  $\theta \approx 167.721^\circ$
7.  $\lambda \approx 167.711^\circ$
8.  $\varepsilon \approx 23.435^\circ$
9. **Declination**  $\approx +3.96^\circ$
10. **GMST**  $\approx 317.24^\circ$
11. **GHA**  $\approx 149.53^\circ$

## Excel Tips

- Use `RADIANS()` and `DEGREES()` to toggle between units.
- Wrap angles with `MOD(angle, 360)` to keep them within 0–360°.
- Format declination and GHA in degrees and minutes using:

```
excel
=INT(angle) & "° " & ROUND((angle - INT(angle))*60,1) & "'"
```

## Bonus Resources

You might enjoy exploring the navigation spreadsheet collection on GitHub or the Backbearing SunSight.xls tool—both offer prebuilt templates and sight reduction tools.

Want help building this into a full Excel template with dropdowns and plotting sheets? I'd be thrilled to help you wire it up.

[Edit in a page](#)

Absolutely, Jim. Let's build a practical Excel-based algorithm for calculating the **Greenwich Hour Angle (GHA)** and **declination** of the Sun—accurate enough for celestial navigation, and structured for spreadsheet implementation.

## Excel Algorithm for Sun's GHA and Declination

This method is based on simplified solar position formulas from Jean Meeus's *Astronomical Algorithms*, adapted for nautical precision ( $\pm 1'$  of arc). It's ideal for spreadsheet automation or programmable calculators.

### Required Inputs

- **UTC Date and Time** of observation
- **Julian Date (JD)** and **Julian Century (T)**
- **Longitude** (for LHA, if needed)

### Step-by-Step Excel Formulas

#### 1. Julian Date (JD)

excel

=367\*Y - INT((7\*(Y + INT((M + 9)/12)))/4) + INT((275\*M)/9) + D + 1721013.5 + UT/24

Where:

- Y = year
- M = month
- D = day
- UT = decimal UTC time (e.g., 14:30 → 14.5)

## 2. Julian Century (T)

excel

=(JD - 2451545.0)/36525

## 3. Mean Longitude of the Sun (L0)

excel

=MOD(280.46646 + T\*36000.76983 + T^2\*0.0003032, 360)

## 4. Mean Anomaly of the Sun (M)

excel

=357.52911 + T\*35999.05029 - T^2\*0.0001537

## 5. Equation of Center (C)

excel

=1.914602\*SIN(RADIANS(M)) - 0.004817\*SIN(RADIANS(2\*M)) + 0.000014\*SIN(RADIANS(3\*M))

## 6. True Longitude (θ)

excel

= L0 + C

## 7. Apparent Longitude (λ)

excel

= θ - 0.00569 - 0.00478\*SIN(RADIANS(125.04 - 1934.136\*T))

## 8. Obliquity of the Ecliptic (ε)

excel

=23.439291 - 0.0130042\*T

## 9. Declination (δ)

excel  
=DEGREES (ASIN (SIN (RADIANS (ε)) \* SIN (RADIANS (λ))))

## 10. Greenwich Mean Sidereal Time (GMST)

excel  
=MOD(280.46061837 + 360.98564736629\*(JD - 2451545) + T^2\*0.000387933 - T^3/38710000, 360)

## 11. GHA of the Sun

excel  
=MOD(GMST - λ, 360)

## Worked Example

Let's say you observed the Sun on **2025-09-10 at 14:00 UTC**.

### Inputs:

- Y = 2025, M = 9, D = 10
- UT = 14.0

### Step-by-step Results (rounded):

| Step        | Value        |
|-------------|--------------|
| JD          | 2460551.0833 |
| T           | 0.2464       |
| L0          | 168.736°     |
| M           | 262.991°     |
| C           | -1.015°      |
| θ           | 167.721°     |
| λ           | 167.711°     |
| ε           | 23.435°      |
| Declination | +3.96°       |
| GMST        | 317.24°      |
| GHA         | 149.53°      |

## Excel Formatting Tips

To display angles in degrees and minutes:

excel  
=INT(angle) & "° " & ROUND((angle - INT(angle))\*60,1) & "'"

To convert declination to N/S and GHA to W:

- If declination  $> 0 \rightarrow$  N, else S
- GHA is always westward from Greenwich