TWOBIT AERIAL

DJI Matrice 4T
MASTER FIELD MANUAL

Field-start settings, capture-envelope planning, thermal workflow, mapping, processing, and quality assurance.

1 **CORE FIELD RULE: choose detail first; set speed last.**

Height determines GSD and footprint. Shutter controls exposure blur. Readout and aircraft stability control rolling-shutter risk. Interval and overlap control image spacing. Use the smallest active speed limit.

THIS MANUAL INCLUDES

1. Camera, exposure, interval and thermal reference
2. Capture workflow - how every variable connects
3. GSD, footprint and camera-mode geometry
4. Shutter speed, aircraft speed and motion blur
5. Rolling-shutter planning and mode comparison
6. Overlap, interval, line spacing and cadence
7. 200 ft worked example - final start speed
8. RGB roof documentation
9. Thermal roof screening
10. Solar PV thermal inspection
11. Property / site orthomosaic
12. Construction progress documentation
13. Oblique / 3D support
14. Stockpile / volume calculation
15. WebODM, EXIF QA, troubleshooting and sources
16. Altitude scaling - 100 to 300 ft reference

TWOBIT AERIAL

CAMERA REFERENCE

M4T Camera, Exposure & Thermal Reference

Verified camera facts and practical field exposure logic.

WIDE CAMERA	MAX STILL	TIMED JPEG	SHUTTER	VIDEO
48 MP	8064 x 6048	0.7 s listed	2-1/8000 s	4K / 30 fps
1/1.3-inch CMOS	JPEG	M4T 12 MP + 48 MP JPEG	electronic	H.264 / H.265

VISIBLE CAMERA AND EXPOSURE

- Wide camera: 24 mm equivalent, fixed f/1.7. There is no aperture control.
- Use 48 MP when fine GSD matters; use 12 MP when coarser detail is acceptable.
- Mapping shutter target: 1/1000-1/2000 when light permits; about 1/800 is a soft lower limit.
- Start ISO 100. ISO 200 is routine; ISO 400 is usually acceptable. Treat ISO 800+ as a deliberate quality trade.
- Lock white balance for mapped sets and inspect actual EXIF shutter/ISO after the test strip.

THERMAL SETTINGS AND WORKFLOW

- Thermal sensor: 640 x 512; Super Resolution output: 1280 x 1024.
- Prefer 16-bit R-JPEG for roof and solar work; preserve radiometric originals.
- High Gain is the normal starting point for roof/PV work. Use Low Gain for hotter scenes or saturation risk.
- Run manual FFC after meaningful ambient change or when uniformity drifts.
- Capture RGB context for important anomalies and use apparent-anomaly wording.

OFFICIAL TIMED-PHOTO INTERVAL CHOICES

M4T wide camera - 12 MP and 48 MP interval JPEG: DJI's product-specific specification explicitly lists 0.7 / 1 / 2 / 3 / 5 / 7 / 10 / 15 / 20 / 30 / 60 s for both modes. Treat 0.7 s as the listed selectable minimum, then verify sustained realized cadence from EXIF because firmware, storage, controller, and mission behavior can affect actual timing.

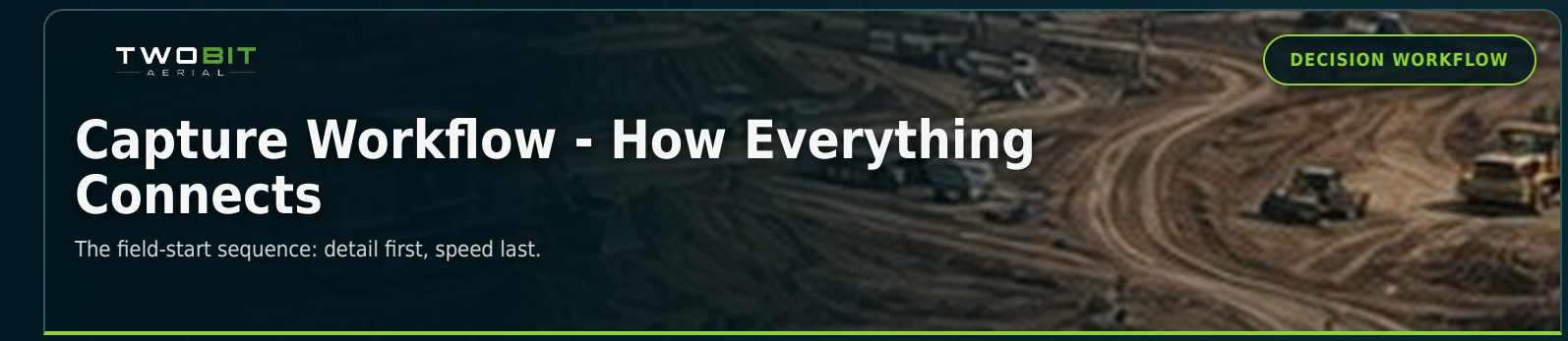
EXPOSURE DECISION LADDER - WHEN TO CHANGE SHUTTER OR ISO

1. **Set shutter floor**
   Use GSD, proposed speed, and quality target. Begin near 1/1000 s for mapping.
2. **Start ISO 100**
   The wide aperture is fixed; ISO is the primary exposure control.
3. **If dark**
   Use ISO 200, then 400 while holding the shutter floor.
4. **If still dark**
   Slow the aircraft so a slower shutter remains inside the blur target, or wait for better light.
5. **If bright**
   Keep ISO 100 and increase shutter speed.
6. **Validate**
   Use EXIF, a 100% image review, histogram/highlight check, and a 30-60 second test strip.

DECISION WORKFLOW

Capture Workflow - How Everything Connects

The field-start sequence: detail first, speed last.



1 DELIVERABLE
Define output, scope, reporting language, and accuracy need.

2 REQUIRED GSD / DETAIL
Choose the smallest feature that must be recognizable or measurable.

3 HEIGHT ABOVE TARGET
Set target-relative height from the GSD requirement - not only launch AGL.

4 CAMERA MODE
Choose 48 MP, 12 MP, video context, or thermal.

5 OVERLAP AND INTERVAL
Choose frontlap/sidelap and confirm actual interval can maintain spacing.

6 SHUTTER AND ISO
Select a shutter floor; use ISO only as needed to hold it.

7 AIRCRAFT SPEED
Use the smallest limit from mission, blur, rolling shutter, cadence, wind, and obstacles.

8 TEST STRIP AND QA
Review EXIF, center/edge sharpness, overlap, turn-frame suppression, and target readability.

FINAL FIELD RULE

START SPEED = MINIMUM OF ALL ACTIVE LIMITS

mission speed band | motion-blur cap | rolling-shutter target | cadence/overlap cap | wind/obstacles | deliverable quality

> Do not increase speed merely because the shutter is fast. A faster shutter reduces ordinary exposure blur; it does not shorten the full-frame rolling readout or guarantee sufficient overlap.

ALTITUDE CONTROLS

GSD, footprint, photo spacing, and how many pixels a given movement crosses.

Higher altitude gives more coverage and motion tolerance, but less detail.

CAMERA MODE CONTROLS

Sampling density, file size, and estimated rolling-readout behavior.

Megapixels alone do not change footprint when FOV/crop are unchanged.

SPEED IS THE RESULT

Set speed only after the detail, mode, shutter, overlap, interval, and mission limits are known.

A mission band is a starting range, not permission to ignore the tighter limit.

GEOMETRY REFERENCE

GSD, Footprint & Camera Modes

Altitude controls detail; camera mode controls sampling density.

48 MP VS 12 MP - SAME NOMINAL FOOTPRINT AT THE SAME HEIGHT

48 MP

8064 x 6048. Finer pixel density and lower GSD. Best when fine detail or mapped texture matters.

12 MP

4032 x 3024. Approximately 2x coarser linear GSD. Same nominal footprint if FOV, aspect ratio, and crop stay unchanged.

At 200 ft above the target, both modes cover about 278 x 209 ft. 48 MP is 0.41 in/px; 12 MP is 0.83 in/px. Confirm Pilot 2 is not applying a crop or aspect-ratio change.

ALTITUDE -> FOOTPRINT -> GSD

Height above target	Footprint W x L	48 MP GSD	12 MP GSD	Typical use
80 ft	111 x 83 ft	0.17 in/px	0.33 in/px	fine detail
100 ft	139 x 104 ft	0.21 in/px	0.41 in/px	fine detail
120 ft	167 x 125 ft	0.25 in/px	0.50 in/px	fine detail
150 ft	209 x 156 ft	0.31 in/px	0.62 in/px	standard mapping
175 ft	243 x 183 ft	0.36 in/px	0.72 in/px	standard mapping
200 ft	278 x 209 ft	0.41 in/px	0.83 in/px	site / construction
225 ft	313 x 235 ft	0.47 in/px	0.93 in/px	site / construction
250 ft	348 x 261 ft	0.52 in/px	1.03 in/px	overview / volume
300 ft	417 x 313 ft	0.62 in/px	1.24 in/px	overview / volume

200 FT MODE COMPARISON - WHAT STAYS THE SAME AND WHAT CHANGES

48 MP STILL

0.414 in/px
Highest visible detail.
DJI-listed timed JPEG minimum: 0.7 s.*

Estimated 60 ms readout makes moving capture more rolling-shutter-sensitive.

12 MP STILL

0.828 in/px
2x coarser linear GSD.
DJI-listed timed JPEG minimum: 0.7 s.*

Estimated 26 ms readout and coarser GSD reduce the rolling-shutter planning index.

SAME FOR BOTH

278 x 209 ft footprint
Same frontlap photo spacing and sidelap line spacing when FOV/crop are unchanged.

Resolution changes sampling density, not nominal coverage.

```
48 MP GSD (in/px) ~= height ft x 0.00207
12 MP GSD (in/px) ~= height ft x 0.00414
Footprint width ft ~= height ft x 1.391
Footprint length ft ~= height ft x 1.043
```

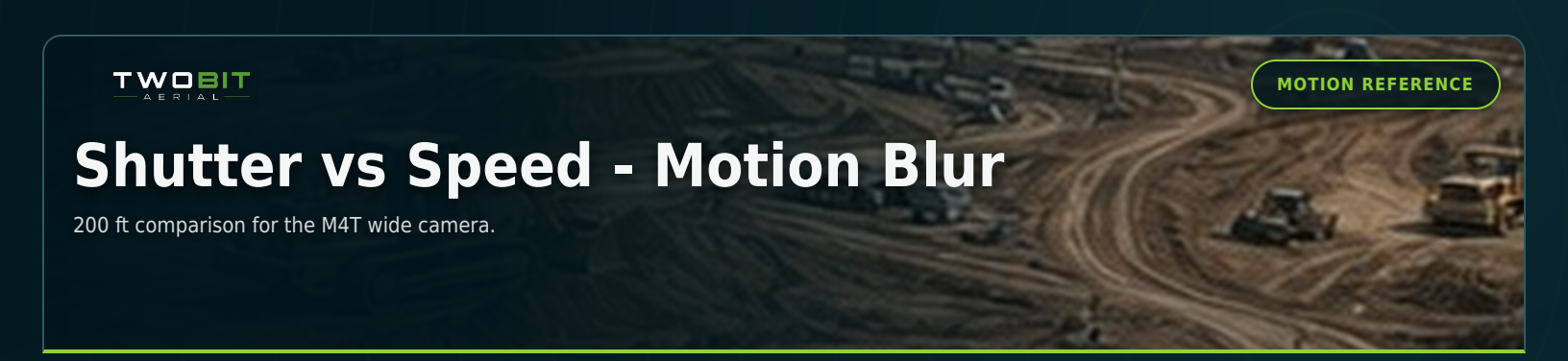
```
Line spacing = footprint width x (1 - sidelap)
Photo spacing = footprint length x (1 - frontlap)

Assumptions: 82 deg diagonal FOV, 4:3 still, nadir, flat target plane.
```

MOTION REFERENCE

Shutter vs Speed - Motion Blur

200 ft comparison for the M4T wide camera.



WHAT THIS PAGE ANSWERS

At **200 ft above the target**, 48 MP GSD is about **0.414 in/px**. The table shows the theoretical aircraft speed at which ordinary exposure translation reaches 0.5 or 1.0 image pixel. It is a blur-only calculation - not a recommended flight speed.

200 FT / 48 MP SHUTTER VS SPEED COMPARISON

Shutter	0.5 px cap	1.0 px cap	Blur at 6 mph	Blur at 8 mph	Field read
1/250	2.9 mph	5.9 mph	1.02 px	1.36 px	too slow for routine moving map
1/500	5.9 mph	11.8 mph	0.51 px	0.68 px	speed-sensitive
1/800	9.4 mph	18.8 mph	0.32 px	0.43 px	usable; test
1/1000	11.8 mph	23.5 mph	0.26 px	0.34 px	strong mapping floor
1/1500	17.6 mph	35.3 mph	0.17 px	0.23 px	high blur margin
1/2000	23.5 mph	47.0 mph	0.13 px	0.17 px	high blur margin

Example: 1/1000 s at 8 mph produces about 0.34 px of ordinary translation blur. The same image can still have rolling-shutter geometry because full-frame readout is a separate process.

MINIMUM SHUTTER BY PROPOSED SPEED - 0.5 PX TARGET

Speed	Theory	Practical floor	Blur at 1/1000
3 mph	1/255	1/500	0.13 px
4 mph	1/340	1/500	0.17 px
5 mph	1/425	1/500-1/800	0.21 px
6 mph	1/510	1/800	0.26 px
7 mph	1/595	1/800	0.30 px
8 mph	1/680	1/1000 preferred	0.34 px

The theoretical value is a minimum. The practical floor adds margin for vibration, focus, gusts, and camera processing.

WHY USE 0.5 PX?

0.5 px is a conservative premium planning target used in aerial-imaging engineering. It is not an M4T specification or universal pass/fail threshold. Treat 0.5-1.0 px as a review zone and inspect the real images at 100%.

WHAT CHANGES MOTION BLUR?

- Faster shutter reduces blur directly.
- Slower ground speed reduces blur directly.
- Higher altitude/coarser GSD reduces pixels of travel, but sacrifices detail.
- ISO does not remove blur; it only helps preserve a faster shutter.

```
Motion blur (px) = speed mph x 17.6 / shutter denominator / GSD (in/px)
Blur speed cap (mph) = target blur px x GSD x shutter denominator / 17.6
```

ROLLING SHUTTER

Rolling Shutter - Planning & Use

200 ft comparison, working estimates, and practical speed targets.

WORKING READOUT ESTIMATE - NOT MEASURED OR OFFICIAL

Use about **60 ms for 48 MP** and **26 ms for 12 MP** as reasonable working proxies based on similar DJI 1/1.3-inch 48 MP cameras. The index below is aircraft travel during the assumed readout divided by GSD. It is a comparison index - not measured visible skew.

200 FT ROLLING-SHUTTER PLANNING INDEX

Speed	48 MP / 60 ms	12 MP / 26 ms	48 MP band
2 mph	5.1 px	1.1 px	low
3 mph	7.7 px	1.7 px	low
4 mph	10.2 px	2.2 px	preferred
5 mph	12.8 px	2.8 px	preferred
6 mph	15.3 px	3.3 px	elevated
7 mph	17.9 px	3.9 px	elevated
8 mph	20.4 px	4.4 px	high
10 mph	25.5 px	5.5 px	high

At 200 ft, each 1 mph adds about 2.55 px to the 48 MP index and 0.55 px to the 12 MP index.

HOW TO USE THE NUMBER

1. Choose height and camera mode.
2. Choose a mission starting speed.
3. Read the index for that speed.
4. If elevated, slow down, fly straight and stable, suppress turn frames, or use 12 MP only when its coarser GSD still meets the deliverable.

CONVERT A TARGET INDEX INTO SPEED

At 200 ft / 48 MP / 60 ms:
10 px -> 3.9 mph
15 px -> 5.9 mph
20 px -> 7.8 mph

```
Max mph = target RS px x GSD x 1000 / (17.6 x readout ms)
```

WHY ROLLING SHUTTER IS DIFFERENT FROM ORDINARY BLUR

TOP ROW -> AIRCRAFT MOVES -> BOTTOM ROW

The frame is read line by line. Position or attitude can change between the first and last rows.

48 MP AT 6 MPH

15.3 px
0.414 in/px GSD
60 ms estimate

Finer GSD and longer estimated readout increase the travel index.

12 MP AT 6 MPH

3.3 px
0.828 in/px GSD
26 ms estimate

Same footprint, but coarser sampling and shorter estimated readout.

<=10 px

Lower relative travel. Preferred for the most geometry-sensitive moving capture.

10-15 px

Good working target. Use stable straight legs and verify a test strip.

15-20 px

Elevated. Often usable, but bias slower for premium mapping.

>20 px

High planning risk. Reduce speed or reconsider mode / stop-and-shoot behavior.

Important: Increasing shutter from 1/1000 to 1/2000 reduces ordinary exposure blur, but it does not shorten the assumed 60 ms full-frame readout. Speed, readout mode, and aircraft attitude stability control rolling-shutter risk.

Overlap, Interval & Cadence

How frontlap, sidelap, footprint, and actual timing constrain speed.

WHAT OVERLAP CHANGES - AND WHAT IT DOES NOT

FRONTLAP

Sets the permitted distance between consecutive photos along the flight line.

More frontlap lowers the maximum speed at a fixed interval.

SIDELAP

Sets flight-line spacing across the mission.

Sidelap does not directly set along-track speed.

OVERLAP CANNOT FIX

It adds redundancy and coverage.

It does not remove exposure blur or rolling-shutter distortion.

200 FT MAXIMUM MPH BEFORE FRONTLAP FALLS BELOW TARGET

Frontlap	0.7 s	1 s	2 s	3 s	5 s
70%	61.0	42.7	21.3	14.2	8.5
75%	50.8	35.6	17.8	11.9	7.1
80%	40.6	28.4	14.2	9.5	5.7
85%	30.5	21.3	10.7	7.1	4.3
90%	20.3	14.2	7.1	4.7	2.8

At 200 ft, along-track footprint is about 208.6 ft. At 80% frontlap, permitted photo spacing is 41.7 ft. With a 2 s actual interval, the cadence cap is 14.2 mph.

200 FT SIDELAP -> FLIGHT-LINE SPACING

Sidelap	Line spacing	Metric
70%	83.5 ft	25.4 m
75%	69.5 ft	21.2 m
80%	55.6 ft	17.0 m
85%	41.7 ft	12.7 m
90%	27.8 ft	8.5 m

48 MP and 12 MP have the same nominal footprint and therefore the same overlap spacing when FOV/crop and height are unchanged.

WORKED SPACING EXAMPLE - 200 FT, 80% FRONTLAP, 6 MPH, 2 S INTERVAL

Along-track footprint 208.6 ft | permitted spacing for 80% frontlap 41.7 ft

Actual photo spacing: 17.6 ft
Actual frontlap: 91.6%
Cadence cap: 14.2 mph

At 6 mph, overlap has substantial margin. Rolling shutter - not cadence - is the tighter quality constraint in the 200 ft example.

```
Photo spacing = footprint length x (1 - frontlap)
Cadence speed cap = photo spacing / actual interval x 0.6818
```

USE ACTUAL EXIF TIMING

DJI's M4T product-specific specs list 0.7 s as a selectable minimum for both 12 MP and 48 MP interval JPEG. Always check DateTimeOriginal + SubSecTimeOriginal over 5-10 consecutive frames and use the realized interval, not only the controller setting.

FINAL START SPEED

Connecting All Limits - 200 ft Example

Motion blur, rolling shutter, overlap, cadence, and mission speed in one decision.

WORKED EXAMPLE - SITE ORTHOMOSAIC AT 200 FT

Planned: 48 MP | 1/1000 s | 80% frontlap | 75% sidelap | 2 s actual interval | 60 ms rolling-shutter estimate | mission band 3-8 mph.

CALCULATE EACH INDEPENDENT LIMIT

Mission upper band	8.0
0.5 px blur cap	11.8
15 px RS target	5.9
20 px RS ceiling	7.8
Cadence cap	14.2

5-6 mph

Premium starting speed: the 15 px rolling-shutter target is the tightest calculated limit. Fly a test strip before increasing speed.

AT 8 MPH, WHY CAN A SHARP IMAGE STILL BE RISKY?

Ordinary blur: 0.34 px - good.
Frontlap with 2 s interval: 88.8% - adequate.
Rolling-shutter index: 20.4 px - high planning band.

The image can look crisp at 100% while still carrying more line-by-line geometric distortion.

FINAL SPEED RULE

FINAL START SPEED = MIN(mission, blur, RS target, cadence, wind/obstacles)

Use 5-6 mph for a premium start. After a clean test strip and processing check, 6-7 mph may be acceptable. Approaching 8 mph uses the 20 px edge of the internal RS band.

SPEED-BY-SPEED RESULT AT 200 FT

Speed	Blur at 1/1000	48 MP RS index	Frontlap at 2 s	Planning read
4 mph	0.17 px	10.2 px	94.4%	premium
5 mph	0.21 px	12.8 px	93.0%	premium
6 mph	0.26 px	15.3 px	91.6%	good start
7 mph	0.30 px	17.9 px	90.2%	elevated RS
8 mph	0.34 px	20.4 px	88.8%	20 px edge

This table is the connection: shutter blur stays low through 8 mph, overlap remains adequate, and rolling shutter becomes the active quality limiter.

IF IMAGE IS DARK

ISO 100 -> 200 -> 400 to protect shutter.

If ISO becomes too high, reduce speed so a slower shutter can stay below the blur target.

IF OVERLAP IS WEAK

Shorten interval, reduce speed, or reduce frontlap only when the deliverable permits.

Increasing shutter does not improve photo spacing.

IF RS INDEX IS HIGH

Reduce speed, stabilize straight legs, suppress turn frames, or use 12 MP if its GSD is adequate.

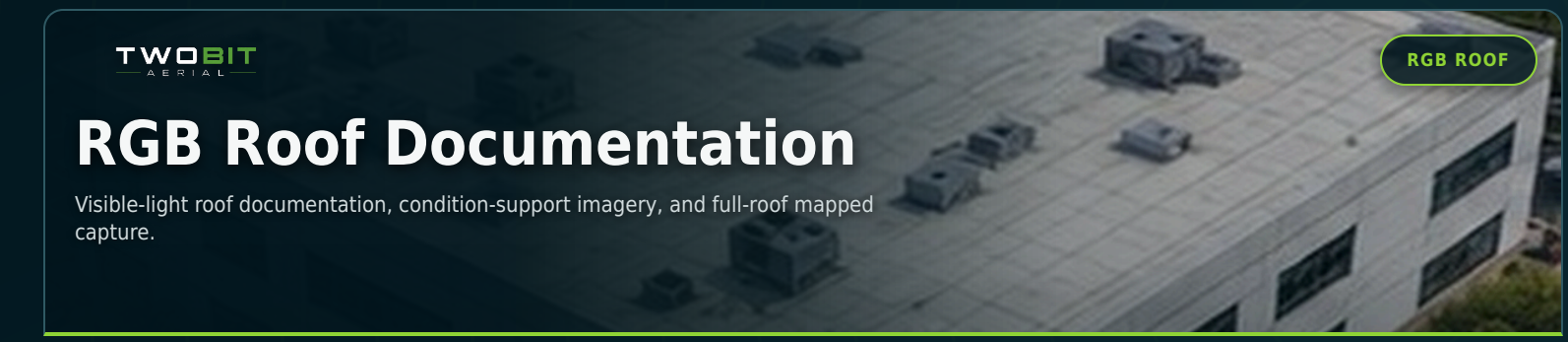
A faster shutter does not reduce full-frame readout time.

TWOBIT AERIAL

RGB ROOF

RGB Roof Documentation

Visible-light roof documentation, condition-support imagery, and full-roof mapped capture.



BEST CONDITION
Bright overcast
or stable sun

HEIGHT
10-100 ft
above roof

START SPEED
1-6 mph
detail dependent

OVERLAP
85 / 80-85
mapped

MARGIN
15-25 ft
beyond roof edge

BEST
Stable light; target readable.

USABLE
Minor glare/wind; adjust and verify.

LIMITED
Heavy shadow, gusts, or weak texture.

POSTPONE
Safety or data quality cannot be controlled.

1. RECOMMENDED HEIGHT AND START SPEED

Use case	Height / distance	Start speed
Close detail photos	10-30 ft	**1-3 mph**
Premium detail pass	25-50 ft	**2-4 mph**
Full roof mapped set	40-70 ft	**3-5 mph**
Large commercial overview	60-100 ft	**4-6 mph**

2. CAMERA / EXPOSURE

- Use 48 MP when maximum detail matters.
- Shutter 1/1000-1/2000 preferred; about 1/800 is the soft lower limit.
- Start ISO 100; use 200-400 only as needed to hold shutter.
- Lock white balance and check seams, drains, flashing, edges, and membrane texture.

3. METHOD / STRATEGY

- Use a nadir grid for mapped products.
- Add targeted oblique/manual detail passes for parapets, penetrations, and equipment.
- Measure height from the roof surface, not only launch AGL.
- Include 15-25 ft beyond the roof edge.

4. ADJUST / PAUSE TRIGGERS

- Glare: change heading or add obliques.
- Heavy overcast: slow down first; then raise ISO if needed.
- Wind: reduce speed and inspect sharpness at 100%.
- Tiny defect hunt: use the 10-30 ft band and slow down.

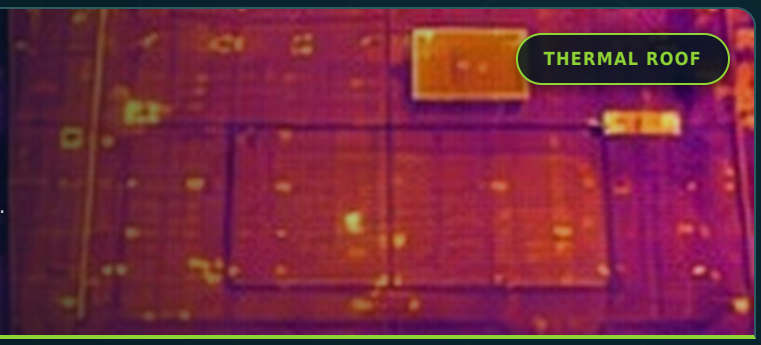
HOW THE VARIABLES CONNECT Detail sets height. Height sets GSD and motion sensitivity. Shutter and ISO protect sharpness; speed is the final control.

TWOBIT AERIAL

THERMAL ROOF

Thermal Roof Screening

Apparent thermal-anomaly screening for roof moisture and insulation issues.



BEST SETUP
Sunny day
clear calm evening

TIMING
1-2 hr
after sunset

HEIGHT
30-120 ft
above roof

START SPEED
1-4 mph
slow mapped pass

THERMAL MODE
R-JPEG
High Gain

BEST
Dry roof, low wind, clear sky loading.

USABLE
Minor wind; verify contrast.

LIMITED
Weak loading or unstable conditions.

POSTPONE
Wet, dewy, frosty, or unsafe roof.

1. RECOMMENDED HEIGHT AND START SPEED

Use case	Height / distance	Start speed
Close anomaly follow-up	30-50 ft	**1-2 mph**
Small roof screening	40-70 ft	**1.5-3 mph**
Normal commercial screening	60-90 ft	**2-4 mph**
Broad overview	80-120 ft	**2-4 mph; verify**

2. CAMERA / EXPOSURE

- Prefer 16-bit R-JPEG for roof work.
- High Gain is the normal starting point.
- Use Super Resolution when added detail is useful.
- Capture RGB context and preserve radiometric originals.

3. METHOD / STRATEGY

- Use a slow nadir grid for mapped thermal work.
- Measure height from the roof surface.
- If mapping, use about 85 / 80-85 overlap.
- Run manual FFC after ambient change or uniformity drift.

4. ADJUST / PAUSE TRIGGERS

- Postpone for wet, dewy, or frosty roofs.
- Postpone if wind or weak loading removes thermal separation.
- Fly lower only when useful detail improves safely.
- Use apparent-anomaly language; thermography does not confirm cause or extent.

HOW THE VARIABLES CONNECT Thermal contrast and timing control usefulness. Height and speed preserve anomaly readability and complete coverage.

SOLAR PV THERMAL

Solar PV Thermal Inspection

Thermal screening of rooftop and ground-mount PV arrays under operating load.

BEST SKY
Clear / mostly clear
stable irradiance

BEST TIME
Midday to
early afternoon

HEIGHT
50-150+ ft
above panel plane

START SPEED
2-6 mph
row geometry

IRRADIANCE
700+ W/m2
preferred

BEST
Stable irradiance; modules readable.

USABLE
Minor variation; verify consistency.

LIMITED
Cloud transients or weak module detail.

POSTPONE
System not under load or unsafe conditions.

1. RECOMMENDED HEIGHT AND START SPEED

Use case	Height / distance	Start speed
Residential rooftop arrays	50-80 ft	**2-4 mph**
Commercial module-level	80-120 ft	**3-5 mph**
Large/string-level overview	120-150+ ft	**4-6 mph if detail remains**

2. CAMERA / EXPOSURE

- Prefer R-JPEG and High Gain.
- Use Super Resolution when module-level detail is required.
- Keep one consistent working palette.
- Verify individual modules remain distinguishable before leaving.

3. METHOD / STRATEGY

- Follow row geometry and stay near-perpendicular to the panel plane.
- Screening overlap about 75-80 / 65-70; increase for mapped products.
- Include 10-20 ft beyond array edges or one extra row/column.
- Pause for passing clouds or unstable irradiance.

4. ADJUST / PAUSE TRIGGERS

- Postpone if the system is not operating under load.
- Postpone for strong passing clouds, wet or heavily soiled modules, or low irradiance.
- If module detail is weak, lower height and reduce speed.
- Recommend qualified PV technician/electrical follow-up.

HOW THE VARIABLES CONNECT Panel-plane height sets module detail. Stable irradiance and slow, repeatable motion matter more than maximum route speed.

TWOBIT AERIAL

SITE ORTHO

Property / Site Orthomosaic

Property mapping, commercial-site overviews, and clean orthomosaic deliverables.

BEST CONDITION
Bright overcast
or stable sun

HEIGHT
120-225 ft
target-relative

START SPEED
3-8 mph
GSD dependent

OVERLAP
80-85 / 75-80
front / side

CRS
EPSG:6511
Missouri Central

BEST
Stable light, rich texture, clear control.

USABLE
Minor glare/wind; verify seams.

LIMITED
Low texture, hard shadows, or gusts.

POSTPONE
Unsafe wind or quality cannot be controlled.

1. RECOMMENDED HEIGHT AND START SPEED

Use case	Height / distance	Start speed
Small property / high detail	120-150 ft	**3-5 mph**
Normal property / commercial	150-175 ft	**4-6 mph**
Larger site / lower detail	175-225 ft	**5-8 mph**

2. CAMERA / EXPOSURE

- Use 48 MP for the finest GSD.
- Shutter about 1/1000-1/1600 preferred.
- ISO 100-200 preferred; up to 400 usually acceptable.
- Lock white balance; inspect pavement edges, roof lines, texture, and landmarks.

3. METHOD / STRATEGY

- Use a standard nadir lawnmower/grid.
- Include 30-75 ft or roughly 10-15% beyond the AOI.
- Choose height from required GSD, then confirm interval capacity.
- Use WebODM for reconstruction and QGIS for final presentation.

4. ADJUST / PAUSE TRIGGERS

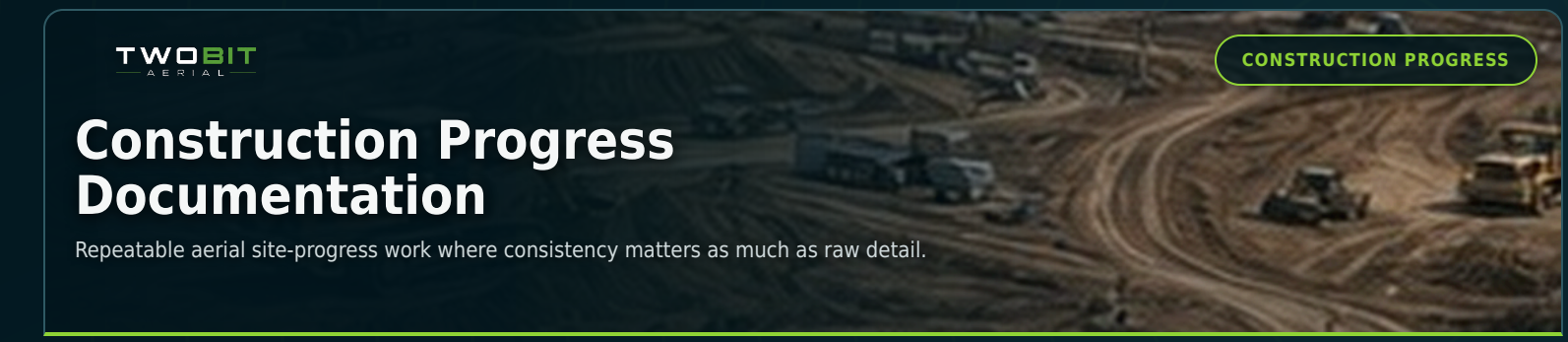
- Weak seams: increase overlap or improve light.
- Low texture: add obliques or increase sidelap.
- Shutter below floor: reduce speed before pushing ISO too high.
- Use stronger control when measurements must support a higher accuracy claim.

HOW THE VARIABLES CONNECT GSD selects height. Height determines footprint and spacing. The slowest of blur, rolling shutter, cadence, and mission limits sets speed.

CONSTRUCTION PROGRESS

Construction Progress Documentation

Repeatable aerial site-progress work where consistency matters as much as raw detail.



BEST CONDITION
Repeatable light
similar time of day

HEIGHT
150-225 ft
target-relative

START SPEED
4-7 mph
repeatable route

OVERLAP
80 / 75-80
front / side

KEY THEME
Consistency
between visits

BEST
Same route, light, and site state.

USABLE
Sunny but repeatable conditions.

LIMITED
Major lighting or seasonal change.

POSTPONE
Wind, dust, or activity destroys quality.

1. RECOMMENDED HEIGHT AND START SPEED

Use case	Height / distance	Start speed
Tighter-detail progress set	150-175 ft	**4-5.5 mph**
Normal recurring progress set	175-200 ft	**5-6.5 mph**
Large site / broader overview	200-225 ft	**6-7 mph**

2. CAMERA / EXPOSURE

- Use 48 MP when it does not compromise pacing.
- Shutter 1/1000+.
- ISO 100-200 preferred; 400 usually fine.
- Keep settings as consistent as practical between visits.

3. METHOD / STRATEGY

- Use the same saved route or as close to the same route as possible.
- Keep enough surrounding area to show site evolution.
- Add repeat oblique views from the same vantage points.
- Deliver dated orthomosaic, repeat photos, and archive-ready folders.

4. ADJUST / PAUSE TRIGGERS

- Repeatability beats squeezing the fastest possible route.
- If more detail is needed on one visit, add a supplemental pass rather than altering the core route.
- Maintain folder naming by date and visit.
- Avoid construction claims outside the defined scope.

HOW THE VARIABLES CONNECT Consistency is the product. Preserve route, height, overlap, exposure logic, and viewpoint between visits.

OBLIQUE / 3D

Oblique Documentation & 3D Support

Edges, facades, parapets, context views, and structured oblique capture.

BEST CONDITION
Bright
low wind

DISTANCE
25-120 ft
from target

START SPEED
1-5 mph
smooth arcs/legs

GIMBAL
35-45 deg
typical oblique

OVERLAP
80-85 / 75-80
structured set

BEST
Stable, textured target and clear standoff.

USABLE
Minor wind; widen standoff.

LIMITED
Occlusion, weak texture, or tight obstacle space.

POSTPONE
Unsafe standoff or uncontrolled yaw.

1. RECOMMENDED HEIGHT AND START SPEED

Use case	Height / distance	Start speed
Close small object	25-50 ft	**1-2.5 mph**
Normal structure detail	40-80 ft	**2-4 mph**
Broad building / context	60-120 ft	**3-5 mph**

2. CAMERA / EXPOSURE

- Use 48 MP for detail; 12 MP only when its GSD is sufficient.
- Shutter 1/1000+.
- ISO 100-200 preferred; up to 400.
- Keep gimbal angle, standoff, and angular motion consistent.

3. METHOD / STRATEGY

- Use a slow structured perimeter, arc, or straight oblique legs.
- Avoid rapid yaw during exposure; smooth aircraft heading is critical.
- Keep enough background/ground texture for reconstruction.
- Include nadir support when a measurable 3D product is required.

4. ADJUST / PAUSE TRIGGERS

- Tight standoff: slow down and increase obstacle margin.
- Featureless walls: add crossing geometry and context.
- Motion blur or leaning edges: slow down, raise shutter, and reduce yaw rate.
- Do not claim complete facades where occlusion remains.

HOW THE VARIABLES CONNECT Obliques make the report understandable. Standoff, yaw stability, texture, and overlap matter as much as resolution.

Stockpile / Volume Calculation

Stockpiles, aggregate yards, and earthwork volume estimates.

BEST CONDITION
Stable light
toe visible

HEIGHT RULE
3-4x
pile height standard

START SPEED
2-5 mph
geometry first

OVERLAP
75-80 / 65-70
minimum

KEY THEME
Protect
toe and base

BEST
Stable light, dry pile, visible toe/base.

USABLE
Minor shadow; verify breaklines.

LIMITED
Deep toe shadow, dust, or active loading.

POSTPONE
Changing pile or cropped/hidden base.

1. RECOMMENDED HEIGHT AND START SPEED

Use case	Height / distance	Start speed
Small stockpile / high detail	2.5-3x pile height	**2-3 mph**
Typical stockpile work	3-4x pile height	**3-4 mph**
Taller or grouped piles	4-5x pile height	**3.5-5 mph**

2. CAMERA / EXPOSURE

- Use the highest still-photo quality that maintains practical cadence.
- Minimum shutter 1/1000+.
- ISO 100-200 preferred; 400 usually fine.
- The toe/base breakline must be visible and not cropped.

3. METHOD / STRATEGY

- Default to a nadir lawnmower/grid.
- Obliques are optional for steep faces, bins, retaining edges, or documentation.
- Fly wider than the pile, then digitize tightly at the visible toe/base.
- Document the base-plane method and reporting units.

4. ADJUST / PAUSE TRIGGERS

- Deep toe shadow, dust, active loading, or changing pile: postpone.
- Small piles: 20-30 ft margins; tall piles: 30-50 ft; groups/yards: 50-100 ft.
- Keep route, datum, and boundary logic consistent for repeat monitoring.
- Good settings cannot rescue a hidden or cropped base.

HOW THE VARIABLES CONNECT Volume quality depends on geometry, control, boundary, and base-plane definition - not only image resolution.

WebODM, EXIF QA, Troubleshooting & Sources

Processing starts, retake triggers, CRS, verification, and field QA.

WEBODM QUICK STARTING PRESETS

Scope	DSM	DEM	Ortho	Feature	Point cloud	Key note
RGB roof	true	1.0	0.75-1.0	ultra	high/ultra	Rolling shutter ON
Thermal roof	true	1.0-2.0	1.0-2.0	high	med/high	Preserve R-JPEG
Site ortho	true	2.0	1.5-2.5	high	high	QGIS final
Construction	true	2.0	1.5-2.0	high	high	Keep route consistent
Volume	true	2.0	1.0	high	high	DSM / cloud QC

Rolling-shutter working estimate: 48 MP about 60 ms; 12 MP about 26 ms - reasonable proxies from similar DJI cameras, not measured or official.

TROUBLESHOOTING / RETAKE TRIGGERS

Problem	Likely cause	First correction
Blurry images	speed too high / shutter too slow	slow down; raise shutter; refly
Weak ortho seams	low overlap / weak texture	increase overlap; improve light
Bad roof edges	too little margin	fly wider; add obliques
Thermal roof weak	poor loading / wind / wet roof	reschedule or label limited
Solar inconsistent	clouds / low irradiance	pause or postpone
Volume questionable	toe hidden / base cropped	refly wider; improve timing
Rolling-shutter lean	speed/yaw/readout mismatch	slow down; avoid turn frames
Measurements challenged	no checkpoints / control	use approximate or controlled language

FIELD QA - VALIDATE BEFORE COMMITTING

- Fly a 30-60 second straight test strip at the planned height, speed, shutter, ISO, overlap, and interval.
- Check 5-10 consecutive EXIF records: ExposureTime, ISO, DateTimeOriginal, SubSecTimeOriginal, ImageWidth/Height, GPS.
- At 100% view, one image pixel equals one screen pixel. Inspect center, edges, corners, fine texture, and high-contrast lines.
- Reject directional smear, inconsistent sharpness, leaning/warped edges, clipped highlights, or turn frames.
- Calculate actual frontlap from ground speed, actual EXIF interval, and along-track footprint.

CRS, WORDING AND SOURCES

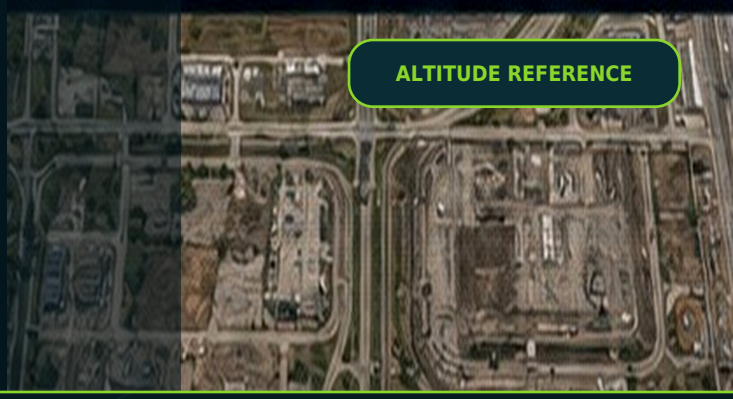
CRS: EPSG:6511 - NAD83(2011) / Missouri Central; published unit is metre. Convert separately for client-facing feet.

Reporting: apparent thermal anomaly; apparent PV thermal anomaly; photogrammetric volume estimate; approximate measurements unless stronger control is stated.

Primary references:

DJI Matrice 4 Series specifications
OpenDroneMap rolling-shutter options
ODM readout database
ODM RSCalibration
EPSG:6511 reference

ALTITUDE REFERENCE



Altitude Scaling

APPLYING THE 200 FT LIMITS

Scale motion-blur, rolling-shutter, and cadence limits without repeating three altitude pages.

WHY THE LIMITS SCALE

NEW LIMIT = 200 FT LIMIT x (HEIGHT / 200)

- For the same camera mode, shutter, overlap, interval, and quality target, GSD and footprint ch.
- Therefore the motion-blur cap, rolling-shutter target speed, and cadence cap also scale approximately with target-relative height.

48 MP SPEED LIMITS BY HEIGHT ABOVE TARGET

Column assumptions: blur = 1/1000 s and 0.5 px; RS = 15 px and 60 ms; cadence = 80% frontlap and 2.0 s actual interval.

Height	Scale	GSD in/px	Blur cap	RS target	Cadence cap
100 ft	0.50x	0.21	5.9 mph	2.9 mph	7.1 mph
150 ft	0.75x	0.31	8.8 mph	4.4 mph	10.7 mph
200 ft	**1.00x**	**0.41**	**11.8 mph**	**5.9 mph**	**14.2 mph**
250 ft	1.25x	0.52	14.7 mph	7.4 mph	17.8 mph
300 ft	1.50x	0.62	17.6 mph	8.8 mph	21.3 mph

The limits above are theoretical planning caps. Final start speed remains the smallest active limit, including the mission band, wind, terrain, obstacles, and test-strip quality.

ROLLING-SHUTTER TARGETS BY HEIGHT

Height	10 px	15 px	20 px
100 ft	2.0	2.9	3.9
150 ft	2.9	4.4	5.9
200 ft	**3.9**	**5.9**	**7.8**
250 ft	4.9	7.4	9.8
300 ft	5.9	8.8	11.8

TwoBit planning interpretation

- 10-15 px: geometry-sensitive work; bias slower.
- 15-20 px: routine mapped capture; test and validate.
- Above 20 px: high relative risk; reduce speed or reconsider mode.

HOW TO USE THIS PAGE

1. Choose required GSD and set height above the actual target.
2. Use the operation page to choose the normal mission speed band.
3. Read the blur, rolling-shutter, and cadence limits for that height.
4. Start at the smallest limit, then validate a straight 30-60 second test strip.

FINAL START SPEED = MINIMUM OF ALL LIMITS

mission | blur | rolling shutter | cadence | wind/terrain/obstacles | QA

12 MP shortcut: same nominal footprint, about 2x coarser GSD.
With the 26 ms proxy, RS index is about 0.22x the 48 MP / 60 ms value.

Assumptions: wide camera, nadir, 48 MP 4:3 geometry, 82 degree diagonal FOV, flat target plane, 60 ms 48 MP working readout estimate, and realized 2.0 s interval. The 60/26 ms values are reasonable estimates based on similar DJI cameras, not M4T measurements or official DJI specifications. DJI lists 0.7 s as a selectable timed-JPEG minimum for both 12 MP and 48 MP; verify actual sustained cadence from EXIF.