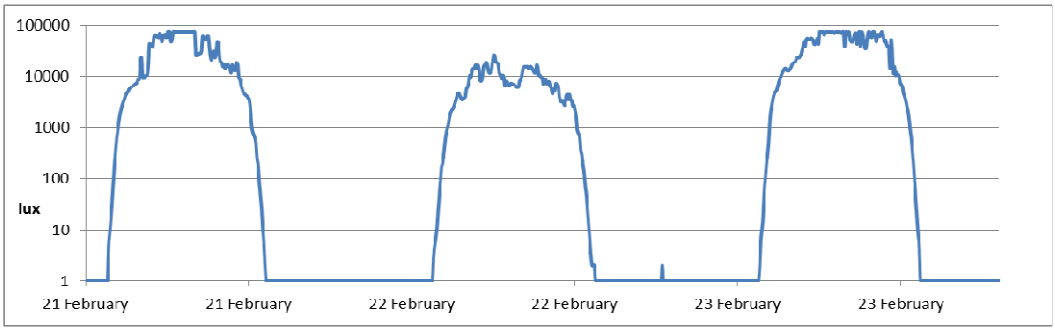
Intigeo® series geolocator

James W. Fox, Oct 2021

Migrate Technology Ltd presents the Intigeo series of light level geolocators. The Intigeo is a miniature archival electronic logging engine capable of recording near full range ambient light with complementing sensor technologies including temperature, atmospheric pressure, acceleration and wet/dry conductivity indicators allowing location tracking of far ranging animals and behavioural studies.

Intigeo loggers are archival; they must be retrieved to obtain recorded data. Using the threshold level geolocation method, primary tracking data can be derived from the identification of sunrise and sunset events in the light record enabling latitude and longitude calculation twice daily e.g. using the R package GeoLight. The light range capability of Intigeos also allows more advanced curve/template statistical modelling analysis e.g. using the R packages FLightR or SGAT.

- Multi-sensing with light level as the core sensor
- Both curve/template and traditional threshold analysis possible
- Start time and device serial number recorded internally
- Intigeo can be started and stopped as many times as battery life allows (data memory is reset when logging is started).



An example of 3 days light data from an Intigeo. Varying cloud thickness can be seen (day 2 is overcast). Threshold level geolocation would normally use less than 10lux but higher values allow behavioural study and cloud compensation, as well as advanced curve analysis and 24hr polar locating.

1. Ambient light level recording

For geolocation, light is sampled every minute but only the maximum sample value within each interval (1/5/10min) is recorded in GEOLOCATION mode. Alternatively, for activity studies, and to reduce power, one sample-and-record per 1/5/10min can be set (CHRONOBIO) via 'Advanced Settings' using the user interface. To increase memory duration, maximum light level can be clipped.

- 1-74,000lux (user 'clipped' setting decreases max)
- Resolution: quasi-logarithmic, 249 discrete levels
- Temperature compensated light sensor

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What this means: Due to the 1min sampling and maximum sample value recording regime, time resolution for geolocation is 1min on the sunrise and sunset curves. High range ambient light is recorded so data is usable for light curve analysis (e.g. fLightR) and behavioural studies (e.g. incubation if leg mounted) as well as pure threshold level geolocation (e.g. GeoLight). High sensitivity at low light levels allows detection of negative Sun angles.

2. Temperature

Some models can record temperature. See the individual logging mode details for temperature sampling and logging frequency. With Modes 1 and 3, temperature is sampled every 5minutes but only the maximum and minimum values are saved every 4hour interval.

- Range: -20'C to +40'C (maximum rating -40'C to +50'C)
- Resolution: 0.125'C for C330, C65-SUPER, BAR, CAR; 1'C for #50,#30; 0.5'C for all others
- Accuracy: +/-0.5'C for C330, C65-SUPER, BAR, CAR; +/-5'C for #50,#30; +/-3'C for all others)
- Note: sensor is located near middle of the device (except for stalked model on request where temperature sensor is on stalk). C330 and C65-SUPER temperature accuracy and resolution can be used for SST correlation (Modes 6-9,11).

What this means: Temperature data may be correlated with weather data, used to indicate flight at altitude and incubation, or used for general environment studies. Note, however, that direct Sun heating effects will elevate recorded temperature during daylight hours and the sensed temperature may also be affected by bird body heat.

3. Wet/dry

Depending on logging mode, conductivity may be sampled and reduced to a 'wet' or 'dry' signal. Some logging modes also record a raw conductivity value.

- Conductivity resolution: 128 levels covering fresh, brackish, saline
- Note: conductivity is designed for wet/dry determination; the quantitative measurement is very crude as response varies with contacts' surface area and temperature. Do not expect consistency for determining salinity; non-linear response.

User can select whether conductivity as low as fresh water is included in the 'wets' count or whether to count only salt water. This makes the 'wet/dry' activity record suitable for fresh water birds e.g. ducks, geese. For salt water species it may be sensible to exclude fresh water (default logger setting) in order to reduce the risk of false counts (e.g. rain, dew) but beware marine inhabitants of estuaries or glacial melt water where there may be low salinity 'sea' water.

What this means: A leg mounted wet/dry logger will indicate immersion. Fresh water detection enables wildfowl and other water bird activity studies. 1hr 'wets' mode 3

enables 1hr resolution for time of arrival of waders at water during migration hops. Beware that wets may be recorded if terminals are in contact with e.g. salty mud, wet-muddy feathers, regurgitated food, faeces, etc as may be present in seabird nests and burrows.

4. Altimeter / barometer / atmospheric pressure

Some models are fitted with an atmospheric pressure sensor (barometer). Currently, these have been only designed for back mount fit on passerines.

- 300 to 1200hPa (approx. sea level to 9km altitude)

What this means: Flight altitude can be determined. Analysis using correlation with global weather data based on geolocation can determine flight altitude. A simpler analysis of dynamic data can be used to determine activity, as well as the beginning and end of a long flight. A practical resolution of just a few meters can be discerned for dynamic analysis.

5. Accelerometer

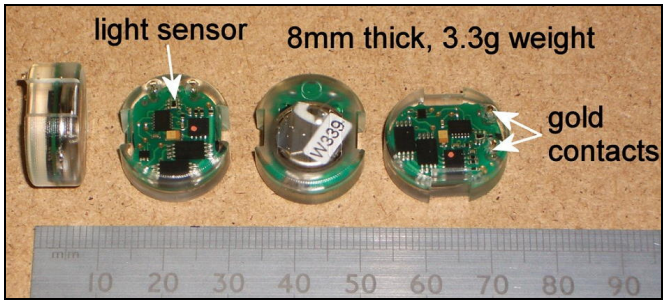
Some models are fitted with an accelerometer. Currently, these have been only designed for back mount fit on passerines. Accelerometers are relatively high power devices and produce large amounts of data that must be greatly compressed to store on tiny loggers. Accelerometers can be used to determine activity (dynamic acceleration) and angular position (static acceleration due to gravity).

- Each measurement is derived from 32 samples at 50Hz
- X-axis average recorded (pitch of bird)
- Z-axis sum of consecutive absolute differences recorded (up/down dynamic movement)

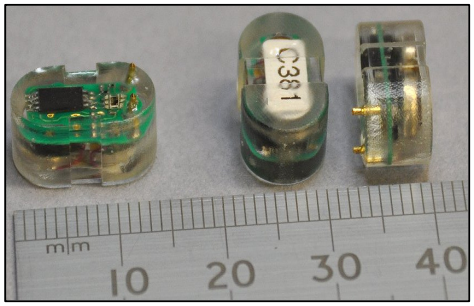
What this means: Data can be used to determine activity. Here are some papers where similar sensor data has been used:

https://doi.org/10.1186/s40462-018-0137-1
https://doi.org/10.1111/jav.01068
https://doi.org/10.1038/ncomms3554
https://doi.org/10.1007/s00359-017-1165-9

6. Example models – many variations are available



Model: Intigeo-C330
17x19x8mm, 3.3g, 2-3yr battery (e.g. seabird leg)



Model: Intigeo-C65 14x8x6mm, 1.0g,
1-2yr battery (e.g. seabird/wader leg)

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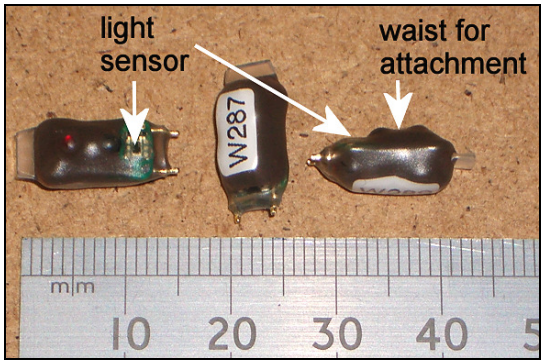
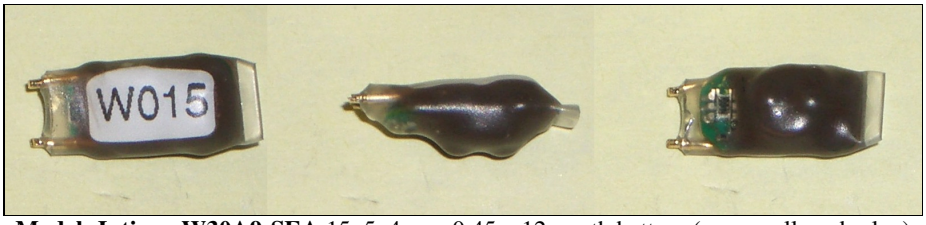
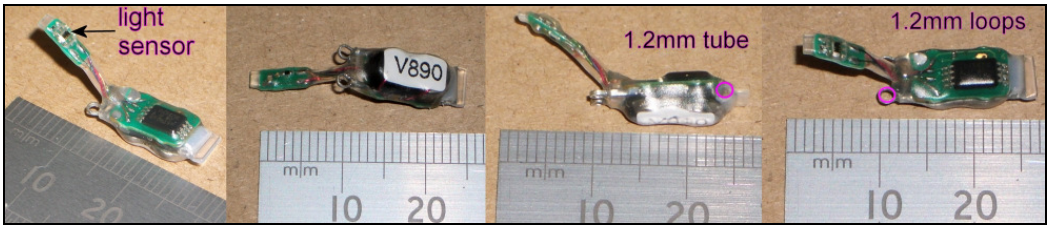


Model: Intigeo-W65A9-SEA
15x6x6mm, 0.7g, 1-2yr battery (e.g. wader leg)

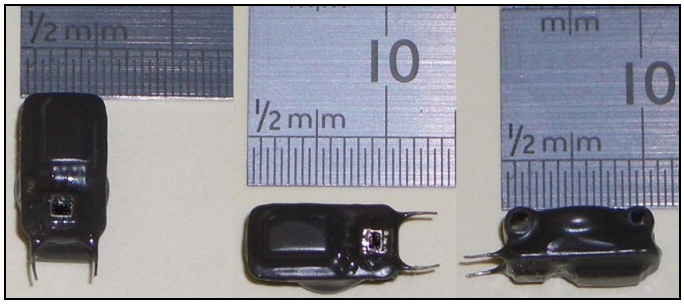
Model: Intigeo-P65C2-7
16x6x6mm excluding stalk, 0.74g,
1-2yr battery (e.g. passerine back)



Model: Intigeo-W30A9-SEA 15x5x4mm, 0.45g, 12month battery (e.g. small wader leg)



Model: Intigeo-P65B1-11 15x6x6mm excluding stalk, 0.71g, 1-2yr battery (e.g. passerine back)



Model: Intigeo-W50Z11-DIP 11x5x5.5mm, 0.45g, 15month battery (e.g. passerine back)

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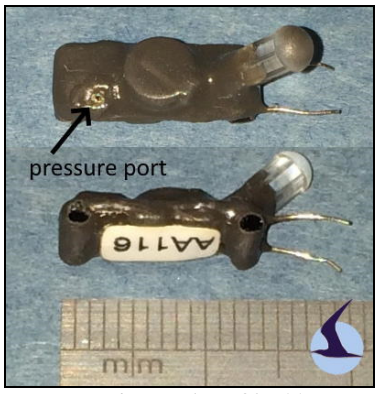
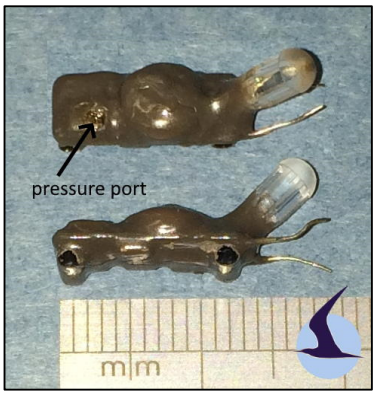
Model: Intigeo-W50B11-DIP
12x5x5.5mm, 0.48g, 15month battery (e.g. passerine back)

Model: Intigeo-W30Z11-DIP
12x5x4mm, 0.32g, 12month battery (e.g. warbler back)



Model: Intigeo-BARP30Z11-7-DIP
14x6x3mm (excl pipe, tubes, contacts) 0.43g, 13month battery (e.g. passerine back)



Model: Intigeo-CARP30Z11-7-DIP
14x6x4mm (excl pipe, tubes, contacts) 0.49g, 14month battery (e.g. passerine back)

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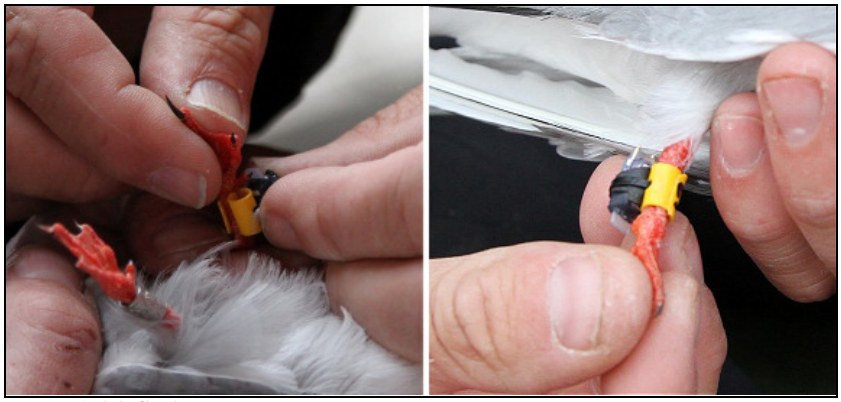
7. Typical manufactured weights

	g
W30Z11-DIP	0.32
P30Z11-7-DIP	0.36
BARW30Z11-DIP	0.38
BARP30Z11-7-DIP	0.43
CARW30Z11-DIP	0.44
W50Z11-DIP	0.45
W30A9-SEA	0.45
W50B11-DIP	0.48
CARP30Z11-7-DIP	0.49
P50Z11-7-DIP	0.50
W50B11	0.54
P50B11-7-DIP	0.55
W65B1-DIP	0.60
P50B11-7	0.63

	g
P50B22-11	0.65
W65C1	0.67
W65A9-SEA	0.70
P65B1-11	0.71
P65B1-7	0.72
P65C2-7	0.74
P50A22-11-SEA	0.75
P65A9-20	0.77
P65C2-11	0.77
P65A11-11-SEA	0.81
P65C2-25	0.84
P65A22-11-SEA	0.87
C65	1.00
C330	3.30

Other variations possible - let us know your requirements



Fitting an **Intigeo-W65A9-SEA** to the leg of a small seabird, copyright Maarten Loonen. The overlapping PVC leg ring is opened and slipped around the leg. The logger has already been wrapped with a small amount of stretched self-amalgamating tape to provide grip to the tie that passes through holes in the ring. The light sensor must not be obscured by the tape. If careful, a small amount of cyanoacrylate glue can be used to seal the leg ring.

8. Model ordering key

Model key								
Hard case (most rugged for seabirds and waders)								
(very hard case, gold contacts, no loops, no tubes, no stalk nor light pipe)								
C65-NOT / C65-COOL	1.0g, est. 1-2yr battery life (-NOT = no temperature, -COOL = temperature sensing)							
C65-SUPER	1.0g, est. 1-2yr battery life, high accuracy temperature, 2 x memory (SST recorded with modes 6-9,11)							
C330	3.3g, est. 2-3yr battery life, high accuracy temperature, 2 x memory (SST recorded with modes 6-9,11)							
Softer case								
e.g.								
P	*65*	*A*	*11*	*-11*	*-SEA*	*-COOL*		
W	*30*	*Z*	*11*		*-DIP*	*-NOT*		
							W	no light stalk nor light pipe; **minimum weight option**
							P	light stalk or light pipe fitted (not for leg mounting)
							30	embedded top small battery; **minimum weight option**
							50	battery under with tube both ends (thicker, shorter)
							65	1-2yr approx battery life
								Longer life means bigger battery which means more weight
							A	gold contact pins (no loops) seawater compatible (can be cut down)
							B	two loops at light sensor end for up to 1mm diameter harness cord
							C	two loops at light sensor end for up to 2mm diameter harness cord
							Z	thin wire contacts (no loops) unsuitable for seawater; **minimum weight option**
								2mm loops add more weight than 1mm loops; B,C and Z are not suitable for saltwater
							1	tube at end opposite to light sensor for up to 1mm diameter harness cord
							2	tube at end opposite to light sensor for up to 2mm diameter harness cord (not for #50/#30)
							9	no tube; **minimum weight option**
								Number repeats if a second tube fitted at other end. 2mm tube is heavier than 1mm tube.
							-7	7mm 45degree optical light pipe
							-11	11mm light sensor on stalk (default angle approx. 30-40degrees) - not available for P50
								A stalked light sensor normally provides the highest quality light data when back mounted
							<no suffix>	standard environmental protection casing
							-SEA	extra manufacturing steps increasing seawater protection (adds weight) (not for #50)
							-DIP	thin environmental case (usually sufficient for passerines); **minimum weight option**
								Note: -11 stalk not compatible with -DIP coating
							-NOT	no temperature capability, cheaper option
							-COOL	temperature sensing fitted, more expensive, only useful for logging modes 1-3
e.g. Intigeo-P65A11-11-SEA-NOT (11mm light stalk, 1-2yr, gold contacts, 2x1mm tubes, no temp e.g. harness mounted seaduck)								
e.g. Intigeo-W30Z11-DIP-NOT (no light stalk/pipe, 12month, thin wire contacts, 2x1mm tubes, no temp, e.g. harness mounted warbler								
Not all combinations are possible or advisable - please enquire								
Single mode devices (thin case, not seawater compatible)								
BARW30Z11-DIP	light, barometer, temperature, wire contacts, 2x1mm tubes, 0.38g, 1yr							
BARP30Z11-7-DIP	light, barometer, temperature, wire contacts, 2x1mm tubes, 7mm light pipe, 0.43g, 1yr							
CARW30Z11-DIP	light, barometer, temperature, acceleration, wire contacts, 2x1mm tubes, 0.44g, 1yr							
CARP30Z11-7-DIP	light, barometer, temperature, acceleration, wire contacts, 2x1mm tubes, 7mm light pipe, 0.49g, 1yr							

9. How do I attach the Intigeo to the bird?

Attaching anything to a wild animal can have significant adverse effects on survival, reproduction, energetics or behaviour. It is the responsibility of the field researcher to

have secured all local animal handling, capture and tagging permissions required to carry out their studies and to also have performed an impact assessment concerning these aspects. We recommend that you consult your local regulatory body and/or ethics committee. Studies must be conducted in accordance with institutional, national and international guidelines concerning the use of animals in research and/or the sampling of endangered species. Migrate Technology Ltd accept no liability for the use or misuse of any of the suggested attachment methods and recommend that small scale acceptance trials are performed before any large scale study.

Attachment method depends on the species of bird and must be carefully considered. You should be very familiar with your chosen study species and, if you are not, then you should learn about its behaviour and physiology as thoroughly as you can to determine the optimum tag attachment method. Only permitted bird handlers should handle wild birds. To learn from work already undertaken, a review of relevant published geolocator studies should be performed before any practical use commences.

Considerations are similar to those explored over a number of decades using VHF tags. One difference is that geolocators usually need to be attached for at least a year to be useful. VHF tags were often attached with the intention that they fall off after a small number of months. It is possible that birds may have geolocators attached for many years, particularly if site fidelity is low or a study ends. Assessment is therefore complicated by possible deleterious effects accumulating over consecutive years. Unlike VHF tags, geolocators do not have an antenna but may have a short stalk.

An initial trial study should be performed if considered advantageous. A behavioural observation of birds in captivity is another option to be considered as is the testing of attachment methods with a cadaver of the species.

10. Which Intigeo should I choose?

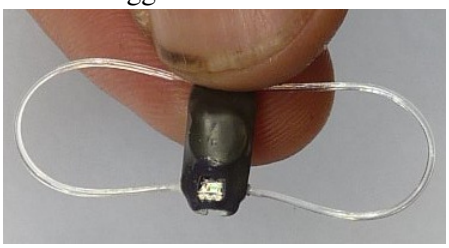
The first step to determine the optimum model is usually to consider the body weight of the species to be studied and decide the maximum weight of logger acceptable to you. This is because, generally, the heavier the logger, the greater its functionality. The weight of logger to be used is a decision to be made by the researcher using their knowledge of the species with guidance from a relevant ethics committee. When leg mounted on seabirds and waders, a maximum weight of 1-2% is often considered. For passerine ‘back pack’ mounting, a maximum weight of 3-4% is often considered.

Generally, geolocators are mounted on the leg or as a back pack. In all methods, obscuration of the light sensor on the geolocator should be kept to a minimum in order to maximise the quality of data. For back mount, near-field shading comes from plumage (and folded wings) and vegetation. For leg mount, near-field shading can come from the body of the bird and light will be somewhat blocked if the bird is

sitting or has its logger leg tucked up. Rather than being wholly problematic, these complexities can create behavioural data such as for incubation.

When assessing weight acceptance, remember to include the weight of the attachment materials. Now that our devices are so small, this can be significant.

Intigeo-W30Z11-DIP (0.32g) on Pied Flycatcher using 'Stretch Magic' harness cord. This Intigeo model is made with two 1mm tubes under the logger. After starting the recording, the two logger contacts were cut off. A suitable length of 'Stretch Magic' was cut, pushed through the tubes and the ends then hot melted together to bond. This formed a figure-of-8 leg-loop (Rappole-Tipton) harness. The loop was then rotated until the bonded ends were inside one of the tubes. A small drop (e.g. using pencil tip) of superglue was then applied to the end(s) of this tube and, by capillary action, was drawn inside, securing the loop. This ensures a minimum weight attachment. By using stretchable harness cord and preparing in advance, bird handling time is minimised (assuming the loop is the correct size for the individual). For this study it may have been advantageous to add a light pipe to the logger to increase data quality but the extra weight and aerodynamic load may have made it unsuitable for this very light weight species. Note also that the orientation of the logger in order to obtain minimum light sensor shading from feathers/wings may not be obvious and may vary between species (and logger models). When you recapture birds, take careful note (or a photo) of how much the sensor is shaded; the manner in which the bird's plumage has settled around the logger may have changed significantly from when deployed. This could help you interpret the data, and help you decide a better mounting technique for next time. Photos by Bryan Thorne, David Price and Malcolm Burgess.



Seabirds and waders

Leg mounting is invariably used for seabirds and is usually the method for waders. Often, a 1% body weight loading for leg mounting is regarded as acceptable for many seabirds and waders with 2% sometimes considered a maximum. Other factors that should be considered include leg length and thickness, positioning on the leg (tibia or tarsus), interference with the tibia-tarsal joint (is a spacer necessary?), torque on the leg (i.e. keep the centre of gravity of the attachment as close to the leg

as possible), potential damage to eggs during incubation, potential damage and wear from rocky habitat, and obscuration of the light sensor by thigh feathers.

A number of different methods can be used to attach electronic tags to the leg but they generally involve attachment to a plastic leg ring or leg 'flag' (this made of special ring PVC plastic; Darvic now appears to have been replaced with Salbex). This plastic can be shaped when heated (freshly boiled water can be hot enough) but there are a number of suppliers who will make rings to order. The mounting ring should not be much shorter than the logger and can be longer. Shorter rings apply greater pressure to the leg and are more likely to cause chaffing.

UV stable nylon cable ties (with stainless steel barb) are commonly used as a quick fit for larger loggers (e.g. C65, C330) on plastic rings but for smaller loggers, another solution is necessary. Certain types of thread, cord or fishing line are some materials used for tying, and are often given a protective coating of adhesive to prevent movement and so reduce the risk of detachment. A couple of layers of stretched self-amalgamating tape (use minimally) around the logger, under the tie or cord, can aid grip and 'bite' of the attachment, particularly if a cable tie is used. Even stainless steel barbed cable ties have been known to loosen very slightly over time so this tape can be important in reducing the risk of the tightened tie falling off. Do not apply too much, as this may encourage barnacle growth and increases the chances of obscuring the light sensor. If using a cable tie, use of a proper cable tie tightening tool allows more control. With a suitable application of a plastics cyanoacrylate adhesive followed by a suitable epoxy resin, W65A9-SEA loggers have been successfully fitted without additional cord or ties.

Harnesses are generally viewed as harmful to seabirds and should be considered with great caution. Harnesses have been used successfully for some species of wader although other species are unsuitable. Unsuitable species include those where weight gain is attained by fat being laid down where a harness would fit. Many migratory birds have considerable weight gain and loss during the year.

For seabirds and waders, where weight will allow, we suggest the C330 or C65. Being hard cased, they cope better with wear and tear. If the C65 is too big or heavy, then we suggest the W65A9-SEA or, with a shorter life, the W30A9-SEA.

Songbirds

A leg-loop (figure-of-8 or Rappole-Tipton) harness is typically used with most songbirds. Choice of harness material varies. Some researchers prefer an elastic material (e.g. 'Stretch Magic') and others non-elastic (e.g. UV-stable nylon mist net repair braid). Some fit an elastic cord within an outer non-elastic sheath. With a suitable model, the harness material can be passed through the Intigeo tube, around the thighs, and knotted to the metal contact loops. A dab of cyanoacrylate glue (or whatever is suitable for the harness material) should be put on the knots and ends of tube once in place, to prevent movement and untying. It is usually best if the harness

cord is not able to move through attachment points once deployed as this may cause detachment through abrasion, or the tag to become twisted.

We cautiously mention here the 4% body weight loading limit sometimes suggested for back pack mounting but note that suitability should always be assessed for the particular species. (Cochran, W.W. (1980). Wildlife telemetry. In Wildlife Management Techniques Manual, 4th edition (S.D. Schemnitz, ed.), 507-520. Wildlife Society, Washington.)

For most passerines and other birds where a back mount is sensible, the stalked P## are suggested. The W## loggers can also be used when necessary but feathers or folded wings may obscure the light sensor reducing the quality of light data. For the -11 P## variants, a posterior pointing light sensor on a stalk is fitted. The aim is to select the most suitable length in order that it just protrudes above the plumage and folded wings (to minimise sensor shading variation but not to significantly increase aerodynamic drag). The length of the stalk is chosen to suit the species. The -7 P## devices are fitted with an optical light pipe. The disadvantage over a stalk is that this reduces sensitivity and is still a little vulnerable to plumage shading variation at the sides. The aim of light level geolocation is to gather light data with as little shading variation as possible; this is not necessarily the highest light exposure, just the most consistent level of shading between the light sensor and the Sun.

Rear mounting loops and a front tube are options to enable easier harness attachment. When choosing a stalked model, consider the species' life style and behaviour e.g. caution with cavity nesters where a stalk may interfere with entry/exit.

For some very aerial birds, e.g. swifts and swallows, data of good quality has been obtained from back mounted loggers without stalks e.g. W##B1, especially if mounted far forward on the bird (with suitable 'body' harness as different from the Rappole-Tipton leg-loop figure-of-8 harness). The loop and tube option is available to aid connection with your harness cord. Thinner models are better for cavity nesters and minimise aerodynamic drag.

If you like, when you have decided your maximum acceptable logger weight, tell us this and the species, along with any preferences regarding loops/tubes or stalk, and we will try to give you sensible options around that weight.

11. How long will the Intigeo record?

Estimated longevity is shown in the tables below.

Higher temperatures accelerate the discharge rate of a logger's internal battery which is why we recommend that they are kept asleep (logging stopped) at refrigeration temperature (e.g. 5'C) in the bag supplied when not in use. Our ratings for battery life are based on 25'C ambient temperature. Where they are exposed to higher temperatures for long periods, battery life will be reduced. Approximate lifetimes indicated are from the date of delivery.

We recommend that sea going loggers are not redeployed after they have been deployed for a year or more.

12. What happens if the Intigeo is dead when I retrieve it?

Sometimes loggers do fail prematurely, most often due to wear and tear, shock or associated sea water ingress and corrosion. Also, they are often retrieved after the battery has naturally expired. The data recorded up until the point of failure will have been stored in a permanent memory that is usually extractable if returned to us. If corrosion or damage is extensive, the memory will not be recoverable.

13. Other necessary items

The IntigeoIF interface unit allows communication with a computer running Microsoft Windows. This is essential as Intigeos are shipped asleep (not logging) and must be started prior to deployment. The interface is also used to download the data and change settings. Interface software is supplied with the IntigeoIF unit and data is saved in time-stamped tab delimited ASCII files.

14. Summary of user programmable recording modes

All values typical values only; individual species' activity may change values.
Further mode details are supplied with the user manual.

Beware - Battery life may expire BEFORE logging duration reached

W30/P30 recording modes - user selectable at start of logging

mode	full light range	+/-5'C temp	cond	wet/dry	wets/tmp /cond (months)	light 1-74klux (months)	clipped 1-1.2klux (months)	est batt life (months)	notes
1	5min	■	■	30s->4h	15	18	35	13	all sensors for general 1yr use
2		■	■	30s->5m	2			13	5min T, C and wets - no geolocation
3	5min	■	■	30s->1h	15	18	35	13	as 1 with different wet/dry
6	5min			30s->10m	28	13	26	13	commonly used clipped with seabirds
7	5min			6s->5m	32	11	21	12	as 6 with higher wet/dry time res
8				6s	40			13	wet/dry only - no geolocation
9	5min			6s	26	11	21	12	similar to mode 7
10	5min					22	43	13	longest 5min light record, light only
11	10min			30s->10m	28	26	40	13	reduced time resolution in light

W50/P50 recording modes - user selectable at start of logging

mode	full light range	+/-5'C temp	cond	wet/dry	wets/tmp /cond (months)	light 1-74klux (months)	clipped 1-1.2klux (months)	est batt life (months)	notes
1	5min	■	■	30s->4h	15	18	35	15	all sensors for general 1yr use
2		■	■	30s->5m	2			15	5min T, C and wets - no geolocation
3	5min	■	■	30s->1h	15	18	35	15	as 1 with different wet/dry
6	5min			30s->10m	28	13	26	15	commonly used clipped with seabirds
7	5min			6s->5m	32	11	21	14	as 6 with higher wet/dry time res
8				6s	40			15	wet/dry only - no geolocation
9	5min			6s	26	11	21	13	similar to mode 7
10	5min					22	43	15	longest 5min light record, light only
11	10min			30s->10m	28	26	40	15	reduced time resolution in light

C65-NOT/C65-COOL/W65/P65 recording modes - user selectable at start of logging

mode	full light range	+/-3'C temp	cond	wet/dry	wets/tmp /cond (months)	light 1-74klux (months)	clipped 1-1.2klux (months)	est batt life (months)	notes
1	5min	■	■	30s->4h	15	18	35	23	all sensors for general 1yr use
2		■	■	30s->5m	2			23	5min T, C and wets - no geolocation
3	5min	■	■	30s->1h	15	18	35	23	as 1 with different wet/dry
6	5min			30s->10m	28	13	26	23	commonly used clipped with seabirds
7	5min			6s->5m	32	11	21	21	as 6 with higher wet/dry time res
8				6s	40			23	wet/dry only - no geolocation
9	5min			6s	26	11	21	19	similar to mode 7
10	5min					22	43	23	longest 5min light record, light only
11	10min			30s->10m	28	26	40	23	reduced time resolution in light

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C65-SUPER recording modes - user selectable at start of logging

mode	full light range	+/- 0.5'C temp	cond	wet/dry	wets/tmp /cond (months)	light 1-74klux (months)	clipped 1-1.2klux (months)	est batt life (months)	notes
1	5min	■	■	30s->4h	30	36	70	23	all sensors for general 1yr use
2		■	■	30s->5m	4			23	5min T, C and wets - no geolocation
3	5min	■	■	30s->1h	30	36	70	23	as 1 with different wet/dry
6	5min	💧		30s->10m	56#	26	52	23	commonly used clipped with seabirds
7	5min	💧		6s->5m	64#	22	42	21	as 6 with higher wet/dry time res
8		💧		6s	80#			23	wet/dry only - no geolocation
9	5min	💧		6s	52#	22	42	19	similar to mode 7
10	5min					44	86	23	longest 5min light record, light only
11	10min	💧		30s->10m	56#	52	80	23	reduced time resolution in light
12	1min	5min			6	6	12	23	light and temp for activity studies
13	5min	5min			14	16	32	23	light and temp for activity studies
14	5min	15min			27	26	53	23	light and temp for activity studies

C330 recording modes - user selectable at start of logging

mode	full light range	+/- 0.5'C temp	cond	wet/dry	wets/tmp /cond (months)	light 1-74klux (months)	clipped 1-1.2klux (months)	est batt life (months)	notes
1	5min	■	■	30s->4h	30	36	70	36	all sensors for general 1yr use
2		■	■	30s->5m	4			36	5min T, C and wets - no geolocation
3	5min	■	■	30s->1h	30	36	70	36	as 1 with different wet/dry
6	5min	💧		30s->10m	56#	26	52	36	commonly used clipped with seabirds
7	5min	💧		6s->5m	64#	22	42	36	as 6 with higher wet/dry time res
8		💧		6s	80#			36	wet/dry only - no geolocation
9	5min	💧		6s	52#	22	42	36	similar to mode 7
10	5min					44	86	36	longest 5min light record, light only
11	10min	💧		30s->10m	56#	52	80	36	reduced time resolution in light
12	1min	5min			6	6	12	36	light and temp for activity studies
13	5min	5min			14	16	32	36	light and temp for activity studies
14	5min	15min			27	26	53	36	light and temp for activity studies

- for very aquatic species, the wet/dry/temperature recording duration may be much reduced (due to SST)

-NOT suffix models have no temperature capability

💧 - max,min,mean immersion temp saved every 8hrs (SST); temp sampled each 20mins continuous wet only

Recording durations extrapolated from Wandering Albatross data. Durations are behaviour dependent.

BARW30Z11-DIP, BARP30Z11-7-DIP Single mode logging only

Full range light 5min (sampled every 1min). Atmospheric pressure and temperature every 30min

User settable option: Chronobio light sampling. 5min pressure and temperature (reduced life)

Expected memory and battery life: 13months

CARW30Z11-DIP, CARP30Z11-7-DIP Single mode logging only

Full range light 5min (sampled every 1min). Atmos pressure, temp, acceleration Xavrg+Zact every 30min

User settable option: Chronobio light sampling. 1min pressure, temp, acceleration (reduced life)

Expected memory and battery life: 14months

All time periods estimated. Battery life reduces at elevated temperatures. Activity affects recording rate.

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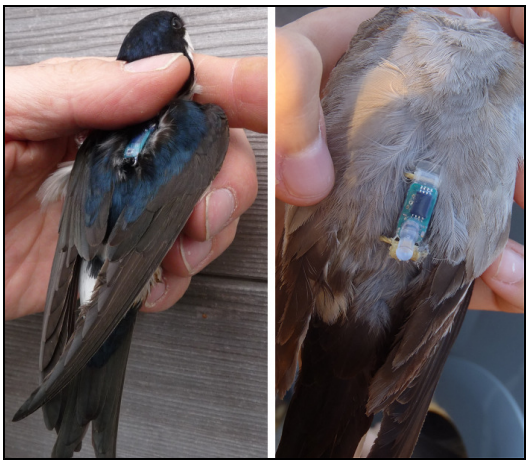
15. Other notes

No harness or attachment materials are supplied with the logging devices. Migrate Technology Ltd provides IntiProc software to enable light to location conversion using the threshold method. This software is free to our customers and uses the R package GeoLight though we strongly recommend the use of R directly to obtain the best functionality. Data is recorded in tab delimited ASCII files suitable for most geolocator analysis tools e.g. the R tools GeoLight, FLightR, SGAT.



Left: **Intigeo-W55B1** (thin package, 1mm loops and tube for harness mounting) copyright Lyndon Kearsley. Right: **Intigeo-W65C2-7** (2mm loops and tube used with leg loop harness) copyright Alex Jahn.

We do not guarantee function against wear and tear or misuse. With some species and habitats significant wear or abrasion can occur leading to premature failure of the device (particularly in a seawater environment). Do not expose to mechanical vibration (e.g. electrical power tools) or to temperatures outside the range -40 to +50'C. Malfunction may result from physical shock, vibration and high levels of electrical or electrostatic interference.

Please contact info@migratetech.co.uk with any queries you may have. Specifications may change.

Disclaimer

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