Convert Latitude and Longitude to Lambert Conformal Conic Projection Co-ordinates (SPCS)

Programmer: Dr. Bill Hazelton

Date: April, 2008. **Version**: 1.0 **Mnemonic**: **S** for Lat/Long to **S**tate Plane (Lambert)

Line	Instruction	Display	User Instructions
S0001	LBL S		
S0002	SF 10		
S0003	LAT–LONG 2 LCC		
S0004	PSE		
S0005	CL x		
S0006	STO F		
S0007	STO L		
S0008	STO P		
S0009	STO Q		
S0010	STO C		
S0011	STO D		
S0012	STO G		
S0013	STO H		
S0014	6378137		a value for ellipsoid (WGS84/NAD83)
S0015	STO A		
S0016	0.00669438		e^2 value for ellipsoid (WGS84/NAD83)
S0017	STO E		
S0018	CHECK–ENTER A		
S0019	PSE		
S0020	INPUT A		
S0021	CHECK–ENTER E		
S0022	PSE		
S0023	INPUT E		
S0024	ENTER LAT 0		
S0025	PSE		
S0026	INPUT P		
S0027	ENTER LONG 0		
S0028	PSE		
S0029	INPUT Q		
S0030	STD PARALLEL 1		
S0031	PSE		
S0032	INPUT C		
S0033	STD PARALLEL 2		
S0034	PSE		
S0035	INPUT D		
S0036	ENTER E 0		
S0037	PSE		

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

Line	Instruction
S0038	INPUT G
S0039	ENTER N 0
S0040	PSE
S0041	INPUT H
S0042	ENTER PT LAT
S0043	PSE
S0044	INPUT F
S0045	ENTER PT LONG
S0046	PSE
S0047	INPUT L
S0048	RCL L
S0049	→HR
S0050	STO L
S0051	RCL F
S0052	→HR
S0053	STO F
S0054	RCL P
S0055	→HR
S0056	STO P
S0057	RCL Q
S0058	→HR
S0059	STO Q
S0060	RCL C
S0061	→HR
S0062	STO C
S0063	RCL D
S0064	→HR
S0065	STO D
****	Calculate m2
S0066	RCL D
S0067	COS
S0068	RCL D
S0069	SIN
S0070	x^2
S0071	RCL× E
S0072	1
S0073	x < > y
S0074	—
S0075	$\sqrt{x}$
S0076	÷
S0077	STO S
****	Calculate m1

Line	Instruction
S0078	RCL C
S0079	COS
S0080	RCL C
S0081	SIN
S0082	x^2
S0083	RCL× E
S0084	1
S0085	x < > y
S0086	—
S0087	$\sqrt{x}$
S0088	÷
S0089	STO R
****	Calculate t1
S0090	RCL C
S0091	SIN
S0092	RCL E
S0093	$\sqrt{x}$
S0094	×
S0095	1
S0096	x < > y
S0097	—
S0098	RCL C
S0099	SIN
S0100	RCL E
S0101	$\sqrt{x}$
S0102	×
S0103	1
S0104	+
S0105	÷
S0106	RCL E
S0107	$\sqrt{x}$
S0108	2
S0109	÷
S0110	y^x
S0111	45
S0112	RCL C
S0113	2
S0114	÷
S0115	—
S0116	TAN
S0117	x < > y
S0118	÷

Line	Instruction
S0119	STO U
****	Calculate t2
S0120	1
S0121	RCL D
S0122	SIN
S0123	RCL E
S0124	$\sqrt{x}$
S0125	×
S0126	—
S0127	RCL D
S0128	SIN
S0129	RCL E
S0130	$\sqrt{x}$
S0131	×
S0132	1
S0133	+
S0134	÷
S0135	RCL E
S0136	$\sqrt{x}$
S0137	2
S0138	÷
S0139	y^x
S0140	45
S0141	RCL D
S0142	2
S0143	÷
S0144	—
S0145	TAN
S0146	x < > y
S0147	÷
S0148	STO V
****	Calculate t0
S0149	1
S0150	RCL P
S0151	SIN
S0152	RCL E
S0153	$\sqrt{x}$
S0154	×
S0155	—
S0156	RCL P
S0157	SIN
S0158	RCL E

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

Line	Instruction
S0159	√x
S0160	×
S0161	1
S0162	+
S0163	÷
S0164	RCL E
S0165	√x
S0166	2
S0167	÷
S0168	y^x
S0169	45
S0170	RCL P
S0171	2
S0172	÷
S0173	—
S0174	TAN
S0175	x < > y
S0176	÷
S0177	STO T
****	Calculate n
S0178	RCL R
S0179	LN
S0180	RCL S
S0181	LN
S0182	—
S0183	RCL U
S0184	LN
S0185	RCL V
S0186	LN
S0187	—
S0188	÷
S0189	STO N
****	Calculate F
S0190	RCL R
S0191	RCL÷ N
S0192	RCL U
S0193	RCL N
S0194	y^x
S0195	÷
S0196	STO J
****	Calculate r_0
S0197	RCL A
S0198	RCL× J
S0199	RCL T
S0200	RCL N

Line	Instruction
S0201	y^x
S0202	×
S0203	STO M
****	Calculate θ
S0204	RCL L
S0205	RCL— Q
S0206	RCL× N
S0207	STO K
****	Calculate r
S0208	1
S0209	RCL F
S0210	SIN
S0211	RCL E
S0212	√x
S0213	×
S0214	—
S0215	RCL F
S0216	SIN
S0217	RCL E
S0218	√x
S0219	×
S0220	1
S0221	+
S0222	÷
S0223	RCL E
S0224	√x
S0225	2
S0226	÷
S0227	y^x
S0228	RCL F
S0229	2
S0230	÷
S0231	45
S0232	x < > y
S0233	—
S0234	TAN
S0235	x < > y
S0236	÷
S0237	RCL N
S0238	y^x
S0239	RCL× J
S0240	RCL× A
S0241	STO B
****	Calculate X and Y
S0242	RCL K

Line	Instruction
S0243	SIN
S0244	RCL× B
S0245	STO X
S0246	RCL M
S0247	RCL K
S0248	COS
S0249	RCL× B
S0250	—
S0251	STO Y
S0252	RCL G
S0253	STO+ X
S0254	RCL H
S0255	STO+ Y
****	Calculate scale factor
S0256	1
S0257	RCL F
S0258	SIN
S0259	x^2
S0260	RCL× E
S0261	—
S0262	√x
S0263	RCL A
S0264	x < > y
S0265	÷
S0266	RCL F
S0267	COS
S0268	×
S0269	RCL÷ N
S0270	RCL÷ B
S0271	1/x
S0272	STO W
S0273	RCL K
S0274	→HMS
S0275	STO K
****	Show results
S0276	RESULTS
S0277	PSE
S0278	EASTING
S0279	PSE
S0280	VIEW X
S0281	NORTHING
S0282	PSE
S0283	VIEW Y
S0284	GRID CONV
S0285	PSE

Line	Instruction
S0286	VIEW K
S0287	PT SCALE FACT
S0288	PSE
S0289	VIEW W
S0290	PROGRAM END
S0291	PSE
S0292	CF 10
S0293	RTN

Notes

(1) The program should be run in RPN mode, as results in ALG mode are unknown.

(2) Latitudes and longitudes should be entered in HP notation, i.e., DDD.MMSS. The grid convergence is displayed in HP notation.

(3) The program may be used for any Lambert Conformal Conic projection, if the appropriate parameters are known. Similarly, any ellipsoid may be used, if its a and e^2 parameters are known. Parameters for a wide range of ellipsoids and all SPCS Lambert zones are included at the end of this document.

(4) Latitudes in the southern hemisphere are negative. Longitudes west of Greenwich are negative, i.e., all longitudes in North America. It is critical to enter the correct sign in calculator when entering values.

(5) Lines with **** are comments only, and should not be entered into the calculator. They are there to make program entry a little easier.

(6) This program is long and often appears to be a stream of meaningless commands. This means that it may be more prone to errors when being entered. It is suggested that the program be entered using the given constants, tested (and the checksum checked), and when it is satisfactory, the values for the zone that are set to zero at the start of the program can be changed to those most suitable for the bulk of the expected work. See the **Localization** section at the end of the document.

(7) When working in SPCS 1927, there are some small differences in Northings between this program and the NGS conversion program. This may be caused by a different method of computing the distance from the pole in days gone by (see the discussion in the **Theory** section). The differences are small (less than 0.25 inch in all places tested thus far) and appear to be larger the further the point is from the pole. The conversions in SPCS 1983 agree to 0.001 m, which is the finest value the NGS program provides.

(8) The scale factor is exactly 1.0000 when the point is on the standard parallels. It is less than 1.0000 between the standard parallels, and greater than 1.0000 outside the standard parallels.

Theory

Converting from geographical co-ordinates (latitude and longitude) to cartesian co-ordinates on a Lambert Conformal Conic projection is a straightforward transformation, if somewhat long-winded. The following is derived from Snyder's *Map Projections – A Working Manual*.

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

If we are working on the ellipsoid, which we really have to do for most cases and certainly for the SPCS, we need the following information in order to convert geographical co-ordinates into grid co-ordinates: a, e^2, ϕ_1, ϕ_2, ϕ_0, λ_0, ϕ and λ. We know a and e^2 for the particular ellipsoid being used, and the fixed latitude and longitude values are already determined for every SPCS zone. The details are provided for all SPCS Lambert Zones at the end of this discussion.

(Note that the SPCS 27 has co-ordinates in US Survey feet, and uses the Clarke 1866 ellipsoid. The SPCS 83 has co-ordinates in meters, and uses the GRS80 spheroid, which effectively is the same as WGS-84. Some states have either the US Survey foot or the International foot as alternative distance units; check which one is in use in the state you are working in at any particular time. Note that there is a datum shift between the two systems (1927 and 1983) as well, and that you cannot really do a direct linear shift between them.

With the basic information, we can compute the co-ordinates as follows:

$$x = r \sin \theta$$

$$y = r_0 - r \cos \theta$$

then use

$$E = E_0 + x$$

$$N = N_0 + y$$

where the following formulae are used. Note that subscripts 0, 1 or 2 imply the use of specific values of ϕ in the formulae for r, m and t at the appropriate places.

The example of r_0 is given below. The terms t, m and F are used only to simplify computation and do not imply any real (or readily apparent) physical quantity or value.

$$r = a F t^n$$

$$\theta = n (\lambda - \lambda_0)$$

$$r_0 = a F t_0^n$$

$$n = \frac{\ln m_1 - \ln m_2}{\ln t_1 - \ln t_2}$$ (constant of the projection or cone)

$$m = \frac{\cos \phi}{\sqrt{1 - e^2 \sin^2 \phi}}$$

$$t = \frac{\tan\left(\frac{\pi}{4} - \frac{\phi}{2}\right)}{\left(\frac{1 - e \sin \phi}{1 + e \sin \phi}\right)^{\frac{e}{2}}}$$

or $$t = \sqrt{\left(\left(\frac{1 - \sin\phi}{1 + \sin\phi}\right)\left(\frac{1 + e\sin\phi}{1 - e\sin\phi}\right)^{e}\right)}$$

$$F = \frac{m_1}{n\, t_1{}^n}$$

$$k = \frac{n\ r}{\nu \cos\phi} \qquad \text{(scale factor at the latitude } \phi\text{)}$$

where ν = the radius of the ellipsoid at the parallel of latitude ϕ

$$\gamma = \theta \qquad \text{(grid convergence at the point)}$$

Note that n, F and r_0 are constants for a particular map or SPCS zone and only need to be computed once.

When computing with these values, you will get results slightly different from those in the published tables for SPCS 27 (although many of these are out of print). The discrepancy is of the order of 20-30 meters, which is relatively small considering the r distances coming from the pole, and the relative error in a SPCS zone is quite small. The reason for this is that for calculating convenience 70 years ago, when the tables were developed, the tables were, in effect, calculated using the following variant of t, i.e.

$$t = \tan\left(\frac{\pi}{2} - \frac{\phi_g}{2}\right)$$

where ϕ_g is the geocentric latitude, also able to be expressed by

$$\phi_g = \arctan((1 - e^2)\tan\phi)$$

t is actually the cotangent of half the co-latitude of the conformal latitude, χ, which is derived by assuming that a sphere was used as a kind of substitute for the ellipsoid in some calculations (see Snyder for greater details of this, if you are interested). As it happens, the expansions for χ and ϕ_g are numerically very nearly the same. However, the small differences still exist in the SPCS 27 tables. There are other smaller differences caused by the slightly lower precision of older desk-top calculating machines, compared to modern equipment, and the adaptation of formulae to suit these machines. However, these discrepancies are pretty small. This program does not take account of these differences, and so there are small differences between the results here (in the Northings only) and the results from the NGS conversion program. These appear to be less than 0.25 inch anywhere that has been tested thus far.

As you can see from the tables below, most of the SPCS Lambert zones adopt ϕ_0 as having a Y or N value of zero. It is chosen so as to be well south of the limits of the zone. For most of the Lambert zones, the central meridian gets a value of 2,000,000 feet (SPCS 27), and a range of meter values for SPCS 83. See the tables below for exact data.

Sample Computations

Example 1

Using the SPCS 1983 ($a = 6{,}378{,}137$ m, $e^2 = 0.006\ 694\ 3800$), the following results are obtained.

Ohio North Zone, 3401: True Origin: $\phi_0 = 39° 40'$, $\lambda_0 = -82° 30'$;
Standard Parallels: $\phi_1 = 40° 26'$, $\phi_2 = 41° 42'$;
False Origin: $E_0 = 600{,}000.000$ m, $N_0 = 0.000$ m.

Latitude = 40° 05' 30" Longitude = –83° 10' 20"

Easting (E) = 542,668.995 m Northing (N) = 47,416.966 m

Grid Convergence (γ) = –0° 26' 29.82" Point Scale Factor (k) = 1.000 082 97

Example 2

Using the SPCS 1927 ($a = 20{,}925{,}832.2$ ft, $e^2 = 0.006\ 768\ 66$), the following results are obtained.

Ohio North Zone, 3401: True Origin: $\phi_0 = 39° 40'$, $\lambda_0 = -82° 30'$;
Standard Parallels: $\phi_1 = 40° 26'$, $\phi_2 = 41° 42'$;
False Origin: $E_0 = 2{,}000{,}000.000$ ft, $N_0 = 0.000$ ft.

Latitude = 40° 05' 30" Longitude = –83° 10' 20"

Easting (E) = 1,811,901.577 ft Northing (N) = 155,564.399 ft

Grid Convergence (γ) = –0° 26' 29.82" Point Scale Factor (k) = 1.000 082 97

Note: the NGS conversion program gave the same results, except for the Northing, which it gave as 155,564.393, a difference of 0.006 ft (about 0.07 inches). Testing other points in this zone indicate a consistent difference of about this amount. This may be because of the different method of computing the distances from the pole (r and r_0) in earlier computations of the zones.

Example 3

Using the SPCS 1927 ($a = 20{,}925{,}832.2$ ft, $e^2 = 0.006\ 768\ 66$), the following results are obtained.

California III Zone (0403), SPCS 1927, $\phi_0 = 36° 30'$, $\lambda_0 = -120° 30'$;
$\phi_1 = 37° 04'$, $\phi_2 = 38° 26'$;
$E_0 = 2{,}000{,}000.000$ ft, $N_0 = 0.000$ ft.

Latitude = 37° 25' 40" Longitude = –119° 45' 20"

Easting (E) = 2,216,169.136 ft Northing (N) = 338,664.251 ft

Grid Convergence (γ) = 0° 27' 20.8" Point Scale Factor (k) = 0.999 945 01

Note: The NGS conversion program give the same results, except for the Northing, which it gives as 338,664.238 ft, a difference of 0.013 ft (about 0.16 inches). Testing other points in this zone indicate a consistent difference of about this amount. This may be because of the different method of computing the distances from the pole (r and r_0) in earlier computations of the zones.

Example 4

Using the SPCS 1983 (a = 6,378,137 m, e^2 = 0.006 694 3800), the following results are obtained.

California III Zone (0403), SPCS 1983, ϕ_0 = 36° 30', λ_0 = –120° 30';
ϕ_1 = 37° 04', ϕ_2 = 38° 26';
E_0 = 2,000,000.000 m, N_0 = 500,000.000 m.

Latitude = 37° 25' 40" Longitude = –119° 45' 20"

Easting (E) = 2,065,886.861 m Northing (N) = 603,227.485 m

Grid Convergence (γ) = 0° 27' 20.8" Point Scale Factor (k) = 0.999 945 01

Running the Program

Press XEQ S to start the program. The calculator briefly displays LAT—LONG 2 LCC, then briefly shows CHECK—ENTER A. The program then stops and displays the prompt for entering the semi-major axis value, while displaying the current default value:

A?
6,378,137.0000 (This is for GRS80/WGS84/NAD83)

If you are happy with this value for the semi-major axis of the ellipsoid, press R/S to continue. Otherwise. Key in a different value (for a different ellipsoid) and press R/S to continue.

The calculator briefly displays CHECK—ENTER E. The program then stops and displays the prompt for entering the eccentricity of the ellipsoid, e:

E?
0.00669438 (This is for GRS80/WGS84/NAD83)

If this value for the eccentricity is correct, press R/S to continue. Otherwise, key in a different value (for a different ellipsoid) and press R/S to continue.

The calculator briefly displays ENTER LAT 0. The program then stops and displays the prompt for entering the origin latitude for the co-ordinate, ϕ_0:

P?
0.0000

Key in the correct latitude in HP notation (DDD.MMSS), and press R/S to continue. In this case, key in 39.40 for Ohio North.

The calculator briefly displays ENTER LONG 0. The program then stops and displays the prompt for entering the longitude of the central meridian of the projection, λ_0. Note that in the western hemisphere, this will be a negative value, and should be in HP notation (DDD.MMSS).

Q?
0.0000

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

Key in the correct longitude, in HP notation and remembering the sign, then press R/S to continue. In this case, key in –82.30 for Ohio North

The calculator briefly displays STD PARALLEL 1. The program then stops and displays the prompt for entering the latitude of one of the standard parallels for the projection, ϕ_1. The value should be entered in HP notation.

C?
0.000000

Key in the correct value and press R/S to continue. In this case, key in 40.26 and press R/S to continue.

The calculator briefly displays STD PARALLEL 2. The program then stops and displays the prompt for entering the latitude of the other standard parallel for the projection, ϕ_2. The value should be entered in HP notation.

D?
0.000000

Key in the correct value and press R/S to continue. In this case, key in 41.42 and press R/S to continue.

The calculator briefly displays ENTER E 0. The program then stops and prompts for the false easting value, or the easting offset. This is the value of the easting at the central meridian (λ_0), denoted E_0.

G?
0.0000

Key in the correct value, and press R/S to continue. In this case, key in 600000.0 and press R/S.

The calculator briefly displays ENTER N 0. The program then stops and prompts for entry of the false northing value, or the northing offset. This is the value of the northing co-ordinate at ϕ_0, λ_0.

H?
0.0000 (This is for UTM)

If this is the correct value (for some zones, it is zero), press R/S to continue. If a different value is desired, key in the value and press R/S. In this case, just press R/S. This is the N_0 value for Ohio North.

The calculator briefly displays ENTER PT LAT. The program stops and displays the prompt for entering the latitude of the point to be converted. This should be entered in HP notation.

F?
0.0000

Key in the latitude of the point in HP notation and press R/S to continue. In this case, key in 40.0530 and press R/S.

The calculator briefly displays ENTER PT LONG. The program then stops and displays the prompt for entering the longitude of the point to be converted. This should be entered in HP notation.

L?
0.0000

Key in the longitude of the point in HP notation and press R/S to continue. In this case, key in —83.1020 and press R/S/

The program displays RUNNING for a short while, then displays RESULTS briefly, followed by EASTING briefly. The program then stops and displays the easting value of the point. In this case, the calculator displays:

X=
542,662.995

This is the easting of the point, in this case in meters. Press R/S to continue. The calculator briefly displays NORTHING, then stops and displays the northing value of the point. In this case, the calculator displays:

Y=
47,416.966

This is the northing of the point, in this case in meters. Press R/S to continue. The calculator briefly displays GRID CONV, then stops and displays the grid convergence value in HP notation. In this case, the calculator displays:

K=
—0.262981976

This is the grid convergence in HP notation, and is —0° 26' 29".82 in more conventional notation. Press R/S to continue. The calculator briefly displays PT SCALE FACT, then stops and displays the point scale factor of the point on the Transverse Mercator projection. In this case, the calculator displays:

W=
1.00008297

This is the point scale factor. Press R/S to continue. The calculator briefly displays PROGRAM END and then comes to an end, returning to the point from which it was called, or to normal operations.

The grid convergence and the scale factor are left on the stack, but any value may be recalled from the appropriate storage registers, as these are not cleared at the end of the program. See the list of the contents of the various storage registers, on the next page of this document.

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

Storage Registers Used

A	Semi-major axis of the ellipsoid being used, a
B	r, distance from the pole to the point
C	ϕ_1, one of the two standard parallels of the projection
D	ϕ_2, one of the two standard parallels of the projection
E	Eccentricity of the ellipsoid, e^2
F	ϕ, latitude of the point to be converted
G	E_0, the false easting or easting offset
H	N_0, the false northing or northing offset
I	N_0, the offset for the northings (the northing at ϕ_0, $\boldsymbol{\lambda_0}$)
J	F, an internal computed value
K	q, the angle between the line from the pole to the point, and the central meridian
L	λ, longitude of the point to be converted
M	r_0, distance from the pole to ϕ_0
N	n, the constant of the projection or cone
P	ϕ_0, the latitude of the co-ordinate origin on the projection
Q	λ_0, the central meridian of the projection
R	m_1, and internal computed value
S	m_2, and internal computed value
T	t_0, and internal computed value
U	t_1, and internal computed value
V	t_2, and internal computed value
W	point scale factor, k
X	Easting co-ordinate of converted point
Y	Northing co-ordinate of converted point

Statistical Registers: not used

Labels Used

Label **S** Length = 1368 Checksum = BBBC

Use the length (LN=) and Checksum (CK=) values to check if program was entered correctly. Use the sample computation to check proper operation after entry.

Flag Used

Flag 10 is set at the start of the program, and cleared at the end. This allows equations to be used as prompts and messages within the program.

Parameters for the Computations

State Plane Co-ordinate System (SPCS) 1983

Several US states use the Lambert Conformal Conic projection for SPCS 1983. The various parameters for each zone in the 1983 system are given in the table below. Use these parameters with the program, together with the GRS80/WGS84/NAD83 ellipsoid parameters, in meters.

	Standard Parallels		Origin Longitude	Origin Latitude	False East	False North
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (m)	N_0 (m)
Alaska						
Zone 10	51° 50'	53° 50'	176° 00'	51° 00'	1,000,000.00	0.00
Arkansas						
North	34° 56'	36° 14'	92° 00'	34° 20'	400,000.00	0.00
South	33° 18'	34° 46'	92° 00'	32° 40'	400,000.00	400,000.00
California						
I	40° 00'	41° 40'	122° 00'	39° 20'	2,000,000.00	500,000.00
II	38° 20'	39° 50'	122° 00'	37° 40'	2,000,000.00	500,000.00
III	37° 04'	38° 26'	120° 30'	36° 30'	2,000,000.00	500,000.00
IV	36° 00'	37° 15'	119° 00'	35° 20'	2,000,000.00	500,000.00
V	34° 02'	35° 28'	118° 00'	33° 30'	2,000,000.00	500,000.00
VI	32° 47'	33° 53'	116° 15'	32° 10'	2,000,000.00	500,000.00
Colorado						
North	39° 43'	40° 47'	105° 30'	39° 20'	914,401.83	304,800.61
Central	38° 27'	39° 45'	105° 30'	37° 50'	914,401.83	304,800.61
South	37° 14'	38° 26'	105° 30'	36° 40'	914,401.83	304,800.61
Connecticut	41° 12'	41° 52'	72° 45'	40° 50'	304800.61	152400.30
Florida						
North	29° 35'	30° 45'	84° 30'	29° 00'	600000.00	0.00
Iowa						
North	42° 04'	43° 16'	93° 30'	41° 30'	1500000.00	1000000.00
South	40° 37'	41° 47'	93° 30'	40° 00'	500000.00	0.00
Kansas						
North	38° 43'	39° 47'	98° 00'	38° 20'	400000.00	0.00
South	37° 16'	38° 34'	98° 30'	36° 40'	400000.00	400000.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		Origin Longitude	Origin Latitude	False East	False North
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (m)	N_0 (m)
Kentucky						
North	37° 58'	38° 58'	84° 15'	37° 30'	500,000.00	0.00
South	36° 44'	37° 56'	85° 45'	36° 20'	500,000.00	500,000.00
Louisiana						
North	31° 10'	32° 40'	92° 30'	30° 30'	1,00,0000.00	0.00
South	29° 18'	30° 42'	91° 20'	28° 30'	1,000,000.00	0.00
Offshore	26° 10'	27° 50'	91° 20'	25° 30'	1,000,000.00	0.00
Maryland	38° 18'	39° 27'	77° 00'	37° 40'	400,000.00	0.00
Massachusetts						
Mainland	41° 43'	42° 41'	71° 30'	41° 00'	200,000.00	750,000.00
Island	41° 17'	41° 29'	70° 30'	41° 00'	500,000.00	0.00
Michigan						
North	45° 29'	47° 05'	87° 00'	44° 47'	8,000,000.00	0.00
Central	44° 11'	45° 42'	84° 22'	43° 19'	6,000,000.00	0.00
South	42° 06'	43° 40'	84° 22'	41° 30'	4,000,000.00	0.00
Minnesota						
North	47° 02'	48° 38'	93° 06'	46° 30'	800,000.00	100000.00
Central	45° 37'	47° 03'	94° 15'	45° 00'	800,000.00	100,000.00
South	43° 47'	45° 13'	94° 00'	43° 00'	800,000.00	100,000.00
Montana	45° 00'	49° 00'	109° 30'	44° 15'	600,000.00	0.00
Nebraska	40° 00'	43° 00'	100° 00'	39° 50'	500,000.00	0.00
New York						
Long Island	40° 40'	41° 02'	74° 00'	40° 10'	300,000.00	0.00
North Carolina	34° 20'	36° 10'	79° 00'	33° 45'	609,601.22	0.00
North Dakota						
North	47° 26'	48° 44'	100° 30'	47° 00'	600,000.00	0.00
South	46° 11'	47° 29'	100° 30'	45° 40'	600,000.00	0.00
Ohio						
North	40° 26'	41° 42'	82° 30'	39° 40'	600,000.00	0.00
South	38° 44'	40° 02'	82° 30'	38° 00'	600,000.00	0.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

			Origin			
	Standard Parallels		**Longitude**	**Latitude**	**False East**	**False North**
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (m)	N_0 (m)
Oklahoma						
North	35° 34'	36° 46'	98° 00'	35° 00'	600,000.00	0.00
South	33° 56'	35° 14'	98° 00'	33° 20'	600,000.00	0.00
Oregon						
North	44° 20'	46° 00'	120° 30'	43° 40'	2,500,000.00	0.00
South	42° 20'	44° 00'	120° 30'	41° 40'	1,500,000.00	0.00
Pennsylvania						
North	40° 53'	41° 57'	77° 45'	40° 10'	600,000.00	0.00
South	39° 56'	40° 58'	77° 45'	39° 20'	600,000.00	0.00
Puerto Rico and Virgin Islands						
1	18° 02'	18° 26'	66° 26'	17° 50'	200,000.00	200,000.00
2 (St. Croix)	18° 02'	18° 26'	66° 26'	17° 50'		
Samoa	–14° 16'	–14° 16'	170° 00'			
South Carolina	32° 30'	34° 50'	81° 00'	31° 50'	609,600.00	0.00
South Dakota						
North	44° 25'	45° 41'	100° 00'	43° 50'	600,000.00	0.00
South	42° 50'	44° 24'	100° 20'	42° 20'	600,000.00	0.00
Tennessee	35° 15'	36° 25'	86° 00'	34° 20'	600,000.00	0.00
Texas						
North	34° 39'	36° 11'	101° 30'	34° 00'	200,000.00	1,000,000.00
North central	32° 08'	33° 58'	98° 30'	31° 40'	600,000.00	2,000,000.00
Central	30° 07'	31° 53'	100° 20'	29° 40'	700,000.00	3,000,000.00
South central	28° 23'	30° 17'	99° 00'	27° 50'	600,000.00	4,000,000.00
South	26° 10'	27° 50'	98° 30'	25° 40'	300,000.00	5,000,000.00
Utah						
North	40° 43'	41° 47'	111° 30'	40° 20'	500,000.00	1,000,000.00
Central	39° 01'	40° 39'	111° 30'	38° 20'	500,000.00	2,000,000.00
South	37° 13'	38° 21'	111° 30'	36° 40'	500,000.00	3,000,000.00
Virginia						
North	38° 02'	39° 12'	78° 30'	37° 40'	3,500,000.00	2,000,000.00
South	36° 46'	37° 58'	78° 3'0	36° 20'	3,500,000.00	1,000,000.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		Origin Longitude	Origin Latitude	False East	False North
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (m)	N_0 (m)
Washington						
North	47° 30'	48° 44'	120° 50'	47° 00'	500,000.00	0.00
South	45° 50'	47° 20'	120° 30'	45° 20'	500,000.00	0.00
West Virginia						
North	39° 00'	40° 15'	79° 30'	38° 30'	600,000.00	0.00
South	37° 29'	38° 53'	81° 00'	37° 00'	600,000.00	0.00
Wisconsin						
North	45° 34'	46° 46'	90° 00'	45° 10'	600,000.00	0.00
Central	44° 15'	45° 30'	90° 00'	43° 50'	600,000.00	0.00
South	42° 44'	44° 04'	90° 00'	42° 00'	600,000.00	0.00

State Plane Co-ordinate System (SPCS) 1927

Several US states used the Lambert Conformal Conic projection for SPCS 1927. The various parameters for each zone in the 1927 system are given in the table below. Use these parameters with the program, together with the Clarke 1866 ellipsoid in feet.

	Standard Parallels		Origin Longitude	Origin Latitude	False Easting	False Northing
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (ft.)	N_0 (ft.)
Alaska						
Zone 10	51° 50'	53° 50'	176° 00'	51° 00'	3000000.00	0.00
Arkansas						
North	34° 56'	36° 14'	92° 00'	34° 20'	2000000.00	0.00
South	33° 18'	34° 46'	92° 00'	32° 40'	2000000.00	0.00
California						
I	40° 00'	41° 40'	122° 00'	39° 20'	2000000.00	0.00
II	38° 20'	39° 50'	122° 00'	37° 40'	2000000.00	0.00
III	37° 04'	38° 26'	120° 30'	36° 30'	2000000.00	0.00
IV	36° 00'	37° 15'	119° 00'	35° 20'	2000000.00	0.00
V	34° 02'	35° 28'	118° 00'	33° 30'	2000000.00	0.00
VI	32° 47'	33° 53'	116° 15'	32° 10'	2000000.00	0.00
VII	33° 52'	34° 25"	118° 20'	34° 08'	4186692.58	4160926.74

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		Origin Longitude	Origin Latitude	False Easting	False Northing
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (ft.)	N_0 (ft.)
Colorado						
North	39° 43'	40° 47'	105° 30'	39° 20'	2000000.00	0.00
Central	38° 27'	39° 45'	105° 30'	37° 50'	2000000.00	0.00
South	37° 14'	38° 26'	105° 30'	36° 40'	2000000.00	0.00
Connecticut	41° 12'	41° 52'	72° 45'	40° 50'	600000.00	0.00
Florida						
North	29° 35'	30° 45'	84° 30'	29° 00'	2000000.00	0.00
Iowa						
North	42° 04'	43° 16'	93° 30'	41° 30'	2000000.00	0.00
South	40° 37'	41° 47'	93° 30'	40° 00'	2000000.00	0.00
Kansas						
North	38° 43'	39° 47'	98° 00'	38° 20'	2000000.00	0.00
South	37° 16'	38° 34'	98° 30'	36° 40'	2000000.00	0.00
Kentucky						
North	37° 58'	38° 58'	84° 15'	37° 30'	2000000.00	0.00
South	36° 44'	37° 56'	85° 45'	36° 20'	2000000.00	0.00
Louisiana						
North	31° 10'	32° 40'	92° 30'	30° 40'	2000000.00	0.00
South	29° 18'	30° 42'	91° 20'	28° 40'	2000000.00	0.00
Offshore	26° 10'	27° 50'	91° 20'	25° 40'	2000000.00	0.00
Maryland	38° 18'	39° 27'	77° 00'	37° 50'	800000.00	0.00
Massachusetts						
Mainland	41° 43'	42° 41'	71° 30'	41° 00'	600000.00	0.00
Island	41° 17'	41° 29'	70° 30'	41° 00'	200000.00	0.00
Michigan (current)						
North	45° 29'	47° 05'	87° 00'	44° 47'	2000000.00	0.00
Central	44° 11'	45° 42'	84° 20'	43° 19'	2000000.00	0.00
South	42° 06'	43° 40'	84° 20'	41° 30'	2000000.00	0.00
Minnesota						
North	47° 02'	48° 38'	93° 06'	46° 30'	2000000.00	0.00
Central	45° 37'	47° 03'	94° 15'	45° 00'	2000000.00	0.00
South	43° 47'	45° 13'	94° 00'	43° 00'	2000000.00	0.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		Origin Longitude	Origin Latitude	False Easting	False Northing
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (ft.)	N_0 (ft.)
Montana						
North	47° 51'	48° 43'	109° 30'	47° 00'	2000000.00	0.00
Central	46° 27'	47° 53'	109° 30'	45° 50'	2000000.00	0.00
South	44° 52'	46° 24'	109° 30'	44° 00'	2000000.00	0.00
Nebraska						
North	41° 51'	42° 49'	100° 00'	41° 20'	2000000.00	0.00
South	40° 17'	41° 43'	99° 30'	39° 40'	2000000.00	0.00
New York						
Long Island	40° 40'	41° 02'	74° 00'	40° 30'	2000000.00	100000.00
North Carolina	34° 20'	36° 10'	79° 00'	33° 45'	2000000.00	0.00
North Dakota						
North	47° 26'	48° 44'	100° 30'	47° 00'	2000000.00	0.00
South	46° 11'	47° 29'	100° 30'	45° 40'	2000000.00	0.00
Ohio						
North	40° 26'	41° 42'	82° 30'	39° 40'	2000000.00	0.00
South	38° 44'	40° 02'	82° 30'	38° 00'	2000000.00	0.00
Oklahoma						
North	35° 34'	36° 46'	98° 00'	35° 00'	2000000.00	0.00
South	33° 56'	35° 14'	98° 00'	33° 20'	2000000.00	0.00
Oregon						
North	44° 20'	46° 00'	120° 30'	43° 40'	2000000.00	0.00
South	42° 20'	44° 00'	120° 30'	41° 40'	2000000.00	0.00
Pennsylvania						
North	40° 53'	41° 57'	77° 45'	40° 10'	2000000.00	0.00
South	39° 56'	40° 58'	77° 45'	39° 20'	2000000.00	0.00
Puerto Rico and Virgin Islands						
1	18° 02'	18° 26'	66° 26'	17° 50'	500000.00	0.00
2 (St. Croix)	18° 02'	18° 26'	66° 26'	17° 50'	500000.00	100000.00
Samoa	-14° 16'	-14° 16'	170° 00'		500000.00	0.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		Origin Longitude	Origin Latitude	False Easting	False Northing
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (ft.)	N_0 (ft.)
South Carolina						
North	33° 46'	34° 58'	81° 00'	33° 00'	2000000.00	0.00
South	32° 20'	33° 40'	81° 00'	31° 50'	2000000.00	0.00
South Dakota						
North	44° 25'	45° 41'	100° 00'	43° 50'	2000000.00	0.00
South	42° 50'	44° 24'	100° 20'	42° 20'	2000000.00	0.00
Tennessee	35° 15'	36° 25'	86° 00'	34° 40'	2000000.00	100000.00
Texas						
North	34° 39'	36° 11'	101° 30'	34° 00'	2000000.00	0.00
North central	32° 08'	33° 58'	97° 30'	31° 40'	2000000.00	0.00
Central	30° 07'	31° 53'	100° 20'	29° 40'	2000000.00	0.00
South central	28° 23'	30° 17'	99° 00'	27° 50'	2000000.00	0.00
South	26° 10'	27° 50'	98° 30'	25° 40'	2000000.00	0.00
Utah						
North	40° 43'	41° 47'	111° 30'	40° 20'	2000000.00	0.00
Central	39° 01'	40° 39'	111° 30'	38° 20'	2000000.00	0.00
South	37° 13'	38° 21	111° 30'	36° 40'	2000000.00	0.00
Virginia						
North	38° 02'	39° 12'	78° 30'	37° 40'	2000000.00	0.00
South	36° 46'	37° 58'	78° 30'	36° 20'	2000000.00	0.00
Washington						
North	47° 30'	48° 44'	120° 50'	47° 00'	2000000.00	0.00
South	45° 50'	47° 20'	120° 30'	45° 20'	2000000.00	0.00
West Virginia						
North	39° 00'	40° 15'	79° 30'	38° 30'	2000000.00	0.00
South	37° 29'	38° 53'	81° 00'	37° 00'	2000000.00	0.00
Wisconsin						
North	45° 34'	46° 46'	90° 00'	45° 10'	2000000.00	0.00
Central	44° 15'	45° 30'	90° 00'	43° 50'	2000000.00	0.00
South	42° 44'	44° 04'	90° 00'	42° 00'	2000000.00	0.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

Ellipsoids

There are a range of ellipsoids in common or former use. The table below has the a and e^2 values for a number of common (and less common) ellipsoids.

Ellipsoid	a Semi-major Axis	e^2 Eccentricity
GRS80–WGS94–NAD83	6378137 m	0.006 694 38
Clarke 1866 (NAD27)	6378206.4 m	0.006 768 66
Clarke 1866 (NAD27)	20925832.2 ft	0.006 768 66
ANS (Australian)	6378160 m	0.006 694 541 855
Airy 1830	6377563.4 m	0.006 670 54
Bessel 1841	6377397.16 m	0.006 674 372
Clarke 1880	6378249.15 m	0.006 803 511
Everest 1830	6377276.35 m	0.006 637 847
Fischer 1960 (Mercury)	6378166 m	0.006 693 422
Fischer 1968	6378150 m	0.006 693 422
Hough 1956	6378270 m	0.006 722 67
International	6378388 m	0.006 722 67
Krassovsky 1940	6378245 m	0.006 693 422
South American 1960	6378160 m	0.006 694 542
GRS 1967	6378160 m	0.006 694 605
GRS 1975	6378140 m	0.006 694 385
WGS 60	6378165 m	0.006 693 422
WGS 66	6378145 m	0.006 694 542
WGS 72	6378135 m	0.006 694 317 778
WGS 84	6378137 m	0.006 694 38

Localization

In its current form (as given in this document), the program requires that the user enter the zone specific details every time that it is run. If a number of points have to be converted, this is a nuisance, but could be overcome by changing the final line (RTN) to a GTO x statement, and inserting LBL x between lines S0041 and S0042 (where ‘x’ is any unused label letter). This will result in all the lines below that point taking the new label and changing their numbering, as well as changing the length and checksum of the program (which will now be spread across two labels).

If it is intended to do most conversion in the one SPCS zone, then the parameters for that zone can be coded into the program. When such a program is run, the program will prompt for the values (which allows the user to work in a different zone, as needed), but will display and store the regular values for the chosen zone. These can also be changed by changing the program, if a series of points on a different zone are to be converted.

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

The code required to 'hardwire' zone-specific values into the program is given below, based on a specific zone. If we were going to use California Zone III in SPCS 1983, its parameters are:

ϕ_0 = 36° 30'	λ_0 = –120° 30'	a = 6378137 m	e^2 = 0.006 694 38
ϕ_1 = 37° 04'	ϕ_2 = 38° 26'	E_0 = 2,000,000.000 m	N_0 = 500,000.000 m

The resulting code would be as follows, with the rest of the code left out. Note that the angular values are entered in HP notation (DDD.MMSS), as the program converts everything for internal use later.

Line	Instruction	Display	User Instructions
S0001	LBL S		
………	……………		
S0005	CL x		
S0006	STO F		
S0007	STO L		
S0008	36.3		ϕ_0 value of zone
S0009	STO P		
S0010	—120.30		λ_0 value of zone
S0011	STO Q		
S0012	37.04		ϕ_1 value of zone
S0013	STO C		
S0014	38.26		ϕ_2 value of zone
S0015	STO D		
S0016	2000000.0		E_0 value of zone
S0017	STO G		
S0018	500000.0		N_0 value of zone
S0019	STO H		
S0020	6378137		a value for ellipsoid (WGS84/NAD83)
S0021	STO A		
S0022	0.00669438		e^2 value for ellipsoid (WGS84/NAD83)
S0023	STO E		
S0024	CHECK–ENTER A		
S0025	PSE		
S0026	INPUT A		
S0027	…………………		
S0028	…………………		

This will change subsequent line numbers (they will be 6 greater than before), as well as the program length and checksum, but the program should otherwise be unaffected and should run correctly.

Use the values for your preferred zone, and everything should be fine.

Reference

SNYDER, J.P., 1987. *Map Projections—A Working Manual*. U.S. Geological Survey Professional Paper 1395. Washington: US Government Printing Office.