

Readme: Solar Radio Bursts

Note - The following description is derived from the SGD Explanation of Data Reports.

Outstanding Occurrences -- Solar radio emission bursts at fixed frequencies are reported by the worldwide network of observing stations. By the sixth month following observation, most reports have been received and the data are then published in table form in Solar-Geophysical Data (SGD).

The code name used in this publication to identify the station, its alternate station names, if appropriate, the geographic coordinates, and frequencies in MHz on which the station reports are given in a table below.

In the data presentation, bursts reported from different observing stations are joined by brackets when they occur near the same time. Each set of brackets may not always include all of the solar event. The frequency in the MHz precedes the abbreviated station name. Following the name is given the "Type" of event. The Type consists of two columns. The first column is the morphological SGD numerical code which has been used in Solar-Geophysical Data, and the second column is the letter symbol for easier recognition of type. The use of the letter symbol began with the January 1975 data. In the case of OTTA and PENT observations, letters are sometimes appended to the SGD numerical code. See below for explanations. For each event start and maximum phase in UT, duration in minutes, and peak and mean flux densities in $10^{-22} \text{ Wm}^{-2}\text{Hz}^{-1}$ are listed. The letter "E" after the starting time indicates that the event began before the time listed. A "U" after any time denotes an uncertainty in the measurement. A "D" denotes the burst lasted longer than indicated. Information on polarization, positions and other remarks are included in the final column.

Both the tables and illustrations prepared by H. Tanaka, as a part of the "Instruction Manual for Monthly Report", and a table of definitions with a page of illustrations prepared by A. Covington are included in the SGD descriptive text. It is felt that though the meanings are essentially the same, the two viewpoints may aid experimenters in interpreting how the symbols are assigned to bursts by various observatories. Two possibly confusing items seem to remain. Covington feels those GRF bursts with obvious flat tops are a new type of burst best listed under 27(RF) rather than with the GRF symbol since it is also defined as more or less regular rise and fall of continuum with long duration. The illustration of the 10-cm wavelength "Group" with the letter code "SER" may also prove confusing as Covington feels it should rightfully be listed with the SGD number code 41 rather than 42(SER).

The modifications appended to the SGD numerical code for Ottawa and Penticton observations are given here as explained by A.E. Covington, National Research Council Canada. The letter "A" added to a "Simple" event recognizes the longest duration event superimposed upon a long duration event. The use of "A" enables a marginal line to be placed against the entry for the start and extended to include the superimposed events. The presences of unlisted fluctuations or variations which slightly modify the basic form are denoted by the letter "F" added to the SGD numerical code for the event so modified. Records observed simultaneously at widely separated stations have led to the recognition of unique variations of small intensity such as the Rise Only event (which can sometimes be regarded as a discontinuity in the daily level), the absorption only event, the GRF of great duration, isolated events or short duration or spikes, and a single cycle of a sinusoid. Clarification of some of the profiles follows. To identify Rise Only encode as "240", and to identify the Post Rise enhanced level following the rise encode as either "24P" or "25P". Typical profiles based upon the new IAU letter symbols and the modifications suggested are shown in idealized form in the Figure in SGD identified by the SGD numerical code and underlined letters. The various systems are related as indicated by the key to the figures.

In the SGD Descriptive Texts published before 1975 details were given concerning equipment used at Western Hemisphere observatories. Although these are no longer included in the text, information concerning equipment and data reduction may be obtained from the World Data Center A for Solar-Terrestrial Physics (now the World Data Service for Geophysics, Boulder) or from the observatories.

Basically, microwave bursts can be classified into the following types. Explanation of letter symbols:

S	Simple: Mostly non-thermal microwave impulsive "burst" or "decimetric burst".
C	Complex: Combination of a few or many simple bursts.
F	Fluctuation: Minor C sometimes superposed in the main burst.
GB	Great Burst: Major C of special importance.
PRE	Precursor: Pre-burst activity connected to the main burst.
PBI	Post Burst Increase: Tail of the main burst which may be regarded as enhancement of S-component.

GRF Gradual Rise and Fall: Temporal enhancement of S-component or similar activation in the flaring region. It may sometimes start with relatively sharp rise like a simple burst. If this sharp rise can be clearly recognized as simple burst, GRF becomes PBI. Note that both have similar characteristics.

ABS Absorption: Absorption due to surge-like material mainly appears after the burst and is sometimes called post-burst decrease. This phenomenon may occur frequently, but it can only be recognized when the flux comes down to pre-burst level. Temporal fall of flux which is sometimes called negative burst may be listed as ABS, but it may be simply be the temporal fall of emission.

The following three symbols are simply morphological, which may be necessary due to limited observation time, or for the simplicity of tabulation:

R Rise: This may occur as the onset of long-enduring enhancement of S-component associated with other solar events.

FAL Fall.

SER Series of Bursts.

On dm-m-Dm wavelength range, most of the events may be C with F, GB, and PRE as more specific descriptions. The following two symbols were prepared for this range:

NS Noise Storm.

RF Rise and Fall: Defined as more or less irregular rise and fall of continuum with duration of the order of minutes to an hour.

S, FAL and SER may also be used.

These types are illustrated in the SGD text page tables in which samples from different sources are compared.

Polarization information is denoted by the letters "R" (right-handed) or "L" (left-handed). The degree of polarization in percent is shown in two digits. When precise values are not available, the degree of polarization is expressed in symbols "W" (weak), "M" (moderate) or "S" (strong). For example, "83R" means 83% right-hand polarization and "SL" means strong left-hand polarization.

Positional information is indicated by the letters "F" (fan-beam) or "P" (pencil-beam). Position angle is shown in the first three digits, and radial distance is shown by the following three digits. For example, "135120F" means; position angle = 135°, radial distance = 120% of solar radius observed by fan beam.

A Selected Bibliography with Comments Related to Evolution of Burst Profiles at 2700-2800 MHz has been compiled by A.E. Covington. A copy can be made available, on request, from the World Data Center A for Solar-Terrestrial Physics (now the World Data Service for Geophysics, Boulder).

SOLAR RADIO OBSERVATORIES (FIXED FREQUENCY OBSERVATIONS)							
CODE	STATION	ALTERNATE	GEOGRAPHIC		FREQUENCIES REPORTED (MHz)		
NAME		NAME	LAT	LONG			
BERN	Berne, Switzerland	Bumishus	47N	07E	92500,	50000,	35000, 19600, 11800, 8400, 5200, 3100
CRIM	Simferopol, Russia	Crimea	44N	34E			3100
GORK	Gorky, Russia	Zimenki	56N	44E	9100,	2950,	950, 650, 200, 100
HIRA	Hiraiso, Japan		36N	140E	500,	200,	100
HUAN	Huancayo, Peru		12S	75W	9400		
HUMN	Humain, Belgium		50N	05E	600		
IZMI	Moscow IZMIRAN, Russia	Krasnaja	55N	37E	204	(Pakhra)	
KISV	Kislovodsk, USSR		43N	42E	15000,	6100	
KRAK	Krakow, Poland		50N	19E	810,	430	
LEAR	Learmonth, Australia		22S	114E	15400,	8800,	4995, 2695, 1415, 606, 410, 245
NOBE	Nobeyama, Japan		36N	138E	80000,	35000,	17000
ONDR	Ondrejov, Czech Republic		49N	14E	808,	536,	260
PALE	Palehua, Hawaii, USA		21N	158W	15400,	8800,	4995, 2685, 1415, 610, 410, 245
PEKG	Peking, PRC	Beijing	40N	116E	9395,	2840	
PENT	Penticton, Canada		49N	119W	2800		
POTS	Potsdam, Germany	Tremsdorf	52N	13E	9500,	3000,	1470, 234, 113, 68, 30
SGMR	Sagamore Hill, MA, USA		42N	71W	15400,	8800,	4995, 2695, 1415, 609, 410, 245
SVTO	San Vito, Italy		41N	18E	15400,	8800,	4995, 2695, 1415, 610, 410, 245
TORN	Torun, Poland		53N	19E	127		
TRST	Trieste, Italy		46N	14E	408,	327,	237
TYKW	Toyokawa, Japan		34N	137E	9400,	3750,	2000, 1000

UPIC Upice, Czech Republic 50N 16E 33, 29

Event Types According to the Instruction Manual for Monthly Report prepared by H. Tanaka for ICSU-STP-IAU. The key for identifying types of event by numerical SGD code and letter symbol is:

SGD Code	New Letter Symbol	Morphological Classification	URANO Code	Remarks
1	S	Simple 1	1	
2	S/F	Simple 1	1	S + F
3	S	Simple 2	1	
4	S/F	Simple 2F	1	S + F
5	S	Simple	1	
6	S	Minor	0	Defined as simple rise and fall of minor burst with duration 1 or 2 min.
7	C	Minor+	0	Defined as minor burst with second part.
8	S	Spike	1	Self-evident by duration.
20	GRF	Simple 3	1	
21	GRF	Simple 3A	1	"A" means underlying. Clearly superposed burst is to be listed separately, but separation is sometimes difficult and arbitrary. In such cases list as C.
22	GRF	Simple 3F		Fluctuations of short periods should be listed separately.
23	GRF	Simple 3AF	1	
24	R	Rise	8	
25	R	Rise A	8	
26	FAL	Fall		
27	RF			
28	PRE	Precursor		
29	PBI	Post Burst Increase	2	
30	PBI	Post Burst Increase A	2	
31	ABS	Post Burst Decrease		
32	ABS	Absorption		
40	F	Fluctuations	4	
41	F	Group of Bursts	4	A group of minor bursts close to each other.
42	SER	Series of Bursts	4	A series of bursts occur intermittently from base level with considerable time intervals between bursts.
43	NS	Onset of Noise Storm	7	To be listed with starting time, and duration with symbol D.
44	NS	Noise Storm in Progress	7	Starting time with symbol E, and duration with symbol D.
45	C	Complex	3	
46	C	Complex F	3	
47	GB	Great Burst	3	
48	C	Major	5	Defined as complex variation of intensity with large amplitude.
49	GB	Major+	6	Major increase of flux with duration greater than 10 min.

Covington Additions to Tanaka's Proposed IAU Key

SGD Code	New Letter Symbol	Morphological Classification	Remarks
1A	S	Simple 1A	Single simple burst any duration and intensity.
3A	S	Simple 2A	Event separable from other superimposed bursts.
21A	GRF	Simple 3A GRF	
2A	S/F	Simple 1AF	Single simple burst any duration and intensity.
4A	S/F	Simple 2AF	Event separable from other superimposed bursts. Unlisted minor departures and fluctuations.
240	R	Rise only	Discontinuity in daily level without observed restoration, any cause.
240F	R	Rise only F	With unlisted fluctuations.
24P	R	Post Rise	Post Rise enhanced level.
24PF	R	Post Rise F	Post Rise enhanced level with unlisted fluctuations.
26A	FAL	Fall A	Fall with listed superimposed event.

260	FAL	Fall only	Fall only as discontinuity in daily level.
26F	FAL	Fall F	Fall with unlisted minor fluctuations.
27F	RF	Rise and Fall F	Rise and Fall with unlisted minor variations and fluctuations.
27AF	RF	Rise and Fall AF	Rise and Fall with listed superimposed events and unlisted minor variations and fluctuations.
31A	ABS	P.B. Decrease A	Post Burst Decrease with listed superimposed event.
32A	ABS	Absorption A	Absorption with listed superimposed emissive event.
46F	C	Complex F	Complex event with fluctuations.

The U.S. Air Weather Service RSTN observatories (Sagamore Hill, Learmonth, Palehua, and San Vito) report event types using only the following six morphological classifications:

RSTN Burst Type	SGD Translation
01 Noise storm or fluctuations	43 NS if start time exact or uncertain; 44 NS if start time is "in progress".
02 Rise and fall (non-impulsive)	20 GRF (impossible to distinguish between the four types of Simple 3 bursts).
03 Impulsive (<500 sfu)	8 S if duration < 2 min; 4 S/F otherwise.
04 Complex (<500 sfu)	8 S if duration < 2 min; 4 S/F otherwise.
05 Great burst (>500 sfu)	47 GB
06 Complex Great (>500 sfu)	49 GB

Bursts are reported on any given frequency only when they exceed 50 sfu. RSTN station reports include quality (QL), Status (ST) and Type (TYP) in the remarks column. Quality ranges from 1 to 6 where "1" is poor and "6" is excellent.

Status: 1 = Real time
 2 = Final
 3 = Correction
 4 = Deletion

References

Covington, A.E. (TBD)

Tanaka, H. (TBD)