C-band Solid State Power Amplifier (SSPA)

Mitsubishi Electric has many flight experience of C-band SSPA in many commercial satellite programs, as shown in figure-1, since Telecom2 in 1987. Also, the total shipment of SSPA is more than 900. The accumulated operational hours of 540 C-band SSPA present in orbit is exceeding twenty-two million hours. Also, since launch in May 1995, it is renewing the record of non-failure in orbit and the subsequent FIT number is 68 fits for 7 years in orbit operation. (Refer to Figure-2)

MITSUBISHI has delivered more than 920 C-band SSPAs in many satellite programs since 1987.

Major C-band Program	Output power	Q'ty	Efficiency	Remarks
TELECOM-2	11W	20	26%	
INTELSAT-VII/VIIA	10/16/20/30W	223	31%	
ARABSAT-2	15W	40	31%	
INSAT-2 series	8/10W	85	31%	Ext.-C & C Band
N-STAR	8*/17W	18	16*/30%	*Multi carrier, Linearizer
GLOBALSTAR	25*W	216	19*%	*Multi carrier
SINOSAT	21W	32	37%	
INTELSAT-IX	9/19/24W	147	37%	Linearizer
Express-A1/A1R	40W	12	37%	Linearizer
INSAT-3 series	15W/19W	107	36%	Ext. C & C Band, Linearizer
Inmarsat-4	10W	36	12%	Linearizer+ALC

Figure 1 Heritage of C-band SSPA of Mitsubishi Electric Corporation

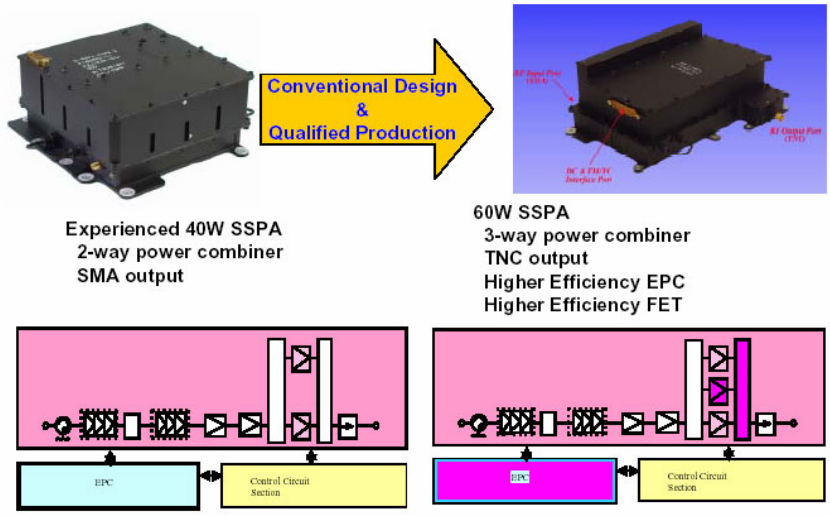

Figure 2 Development of 60WC-band SSPA

Following the lineup of 20 W and 40 W class C-band SSPA for INTELSAT-IX series, 60W class has been developed and qualified. The major performance of 60W C-band SSPA is shown in Table-1. 3 parallel HFET high output elements can generate 60 W RF output with 47% efficiency. Also, small size and weight reduction

have been achieved.

Table—1 Major Performance of 60W C-band SSPA

Parameters	EQM
Frequency Range	300MHz Bandwidth in 3.4-4.2GHz
Reference input power	≤-36 dBm (@Gmax)
Rated output power	P_{2dB}≥60W
Overdrive capability	Up to +15 dBm Input
Nominal gain	84 dB
Gain control range	Total 29 dB in 1 dB step
Efficiency	47% Typ (@P_{2dB})
Heat dissipation	<80W (Worst case=RF OFF)
Inband Spurious	<-70 dBc
EPC Switching Noise	<-65 dBc
Harmonics	<-40dBc (2nd)
	<-40dBc (3rd)
Mass	<1.9 kg
Design Life	15 years excluding 3 years storage

Also, the efficiency, power consumption, heat dissipation versus input level are shown in Figure-3. The heat dissipation when the input level decreases is improved and this merit is convenient from the point of a satellite thermal design.

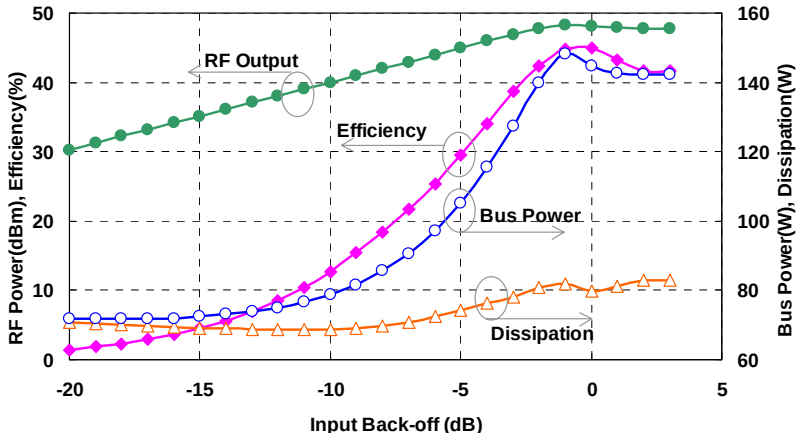

Figure-3 60W C-band SSPA Input/Output Response

The comparison image of SSPA and the same class TWTA is shown in Figure-4.are this 60WC-band SSPA figure-4. Unlike TWTA SSPA includes EPC, linearizer and channel amplifier but also output isolator in one box, this is very good merit in the satellite layout design.

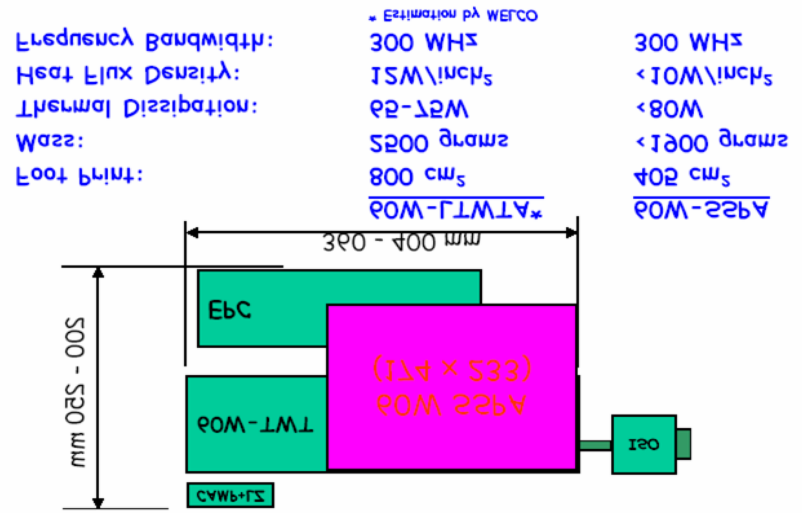

Figure-4 Image of SSP and TWTA comparison

Also, the small foot area and lightweight compared TWTA becomes very more advantageous, in the case that many transponders are required in a small size satellite.