AMETEK® Aerospace & Defense Division



MUIRHEAD AEROSPACE
Synchros

In motion to keep you moving

Contents

Introduction

Muirhead Aerospace

Synchros

Synchros are used to transmit angular data electrically from one location to another where a high degree of accuracy is required. They are essentially variable transformers in which the coupling between windings varies with the rotor position relative to the stator. Several different types are produced to suit particular applications and whilst their external appearance is similar, the internal construction varies to optimise the units' functional requirements. Muirhead's pedigree and capability in the field of Synchros will ensure the most demanding specifications are met. Typical applications include remote positioning of low torque mechanisms, remote control by servo motor driven mechanism, remote digital measurement of angle via a suitable signal converter, remote pointer indication of angular position.

Control Synchros

The design principle of a Control Synchro is to minimise errors in the output signal due to current loading, magnetic non-linearity and temperature rise, by the use of high impedance windings and special attention to the magnetic circuits. The Control Transformer which provides the error signal to a servo amplifier, can be considered a 'null detector and it is most often used in this way. However the 'null' is never zero due to residual voltages. This is due to stray couplings within the laminated stator that result in an in-phase voltage, a quadrature voltage, both at fundamental frequency, plus a number of harmonics. These residual voltage levels are quoted in the performance data tables for each unit.

Differential Transmitters

It is sometimes necessary to add or subtract additional information from a Synchro Chain and Differential Transmitters serve this purpose. They are similar in construction to the other elements except for a 3-phase winding on the rotor.

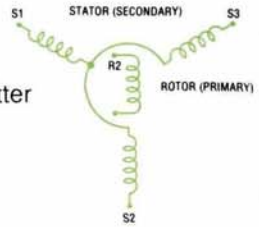
Torque Synchros

The Torque Synchro is designed to provide a light torque output without additional servo components. Current is fed to both the Transmitter and the Receiver from the same source and the winding impedance values are considerably lower than the equivalent control elements. Torque is generated as a result of the interaction of the stator and rotor fields in the receiver which drives the rotor of the Receiver into alignment with that of the Transmitter. The torque / misalignment curve takes sinusoidal form through 360 degrees with maximum values of opposite polarity at 90 and 270 degrees.

Winding Configuration

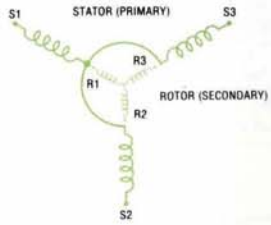
Synchro Function

Control Transmitter
Torque Transmitter
Torque Receiver — Transmitter
Torque Receiver

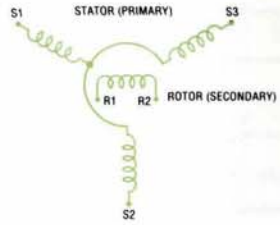


Control Differential Transmitter

Torque Differential Transmitter

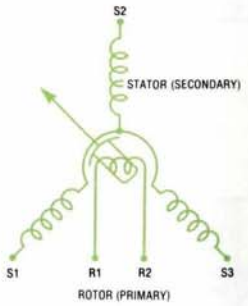


Control Transformer

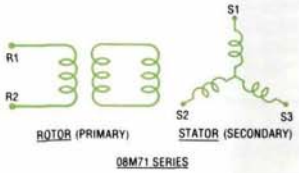


Specialised Synchros

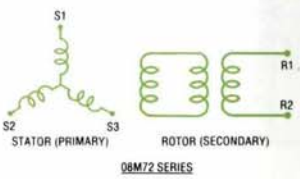
Indicating Receiver
(See page 15)



Brushless Control Transmitter
(See page 14)



Brushless Control Transformer
(See page 14)



Tandem
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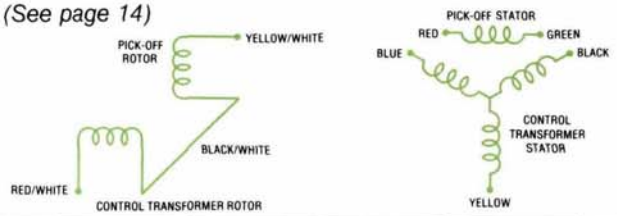


Note

Winding configurations are shown at zero shaft positions viewed from the terminal end. For example, in the wiring configuration for the Control Transmitter, voltage (R1 R2) is approximately in phase with voltage (S2 S1) and voltage (S3 S2).

Damping flywheels are fitted to size 15, 18, and 23 Torque Receivers/Transmitters. For size 08 and 11, damping is achieved by the use of high viscosity bearings.

Mounting Hardware

Each synchro (except size 23) is supplied with a set of three mounting clamps, and where required, shaft nut and washers, together with terminal tags. In addition, Muirhead Vactric can supply at extra cost a variety of hardware. Full details are described in the Mounting Information leaflet. A reference table below shows some of the available choices.

PINION AND SOCKET WRENCHES
Please note that these parts are ordered separately.

Order Ref	*Frame Size*				
	08	11	15	18	23
Pinion wrenches F500/8 & F500/9		*	*	*	*
Socket wrench F500/21	*				
Socket wrench F500/51		*	*	*	
Socket wrench F500/52					*

* *Available*

METRIC CONVERSION FACTORS

Torque	1 gcm = 0.098 mNm
Torque	1 gcm = 1.389×10^{-2} oz in
Torque	1 oz. in. = 72.01 g cm
Inertia	1 oz. in^2 = 1.829×10^{2} g cm^2
Weight	1 oz. = 28.349 g
Distance	1 in. = 25.4mm

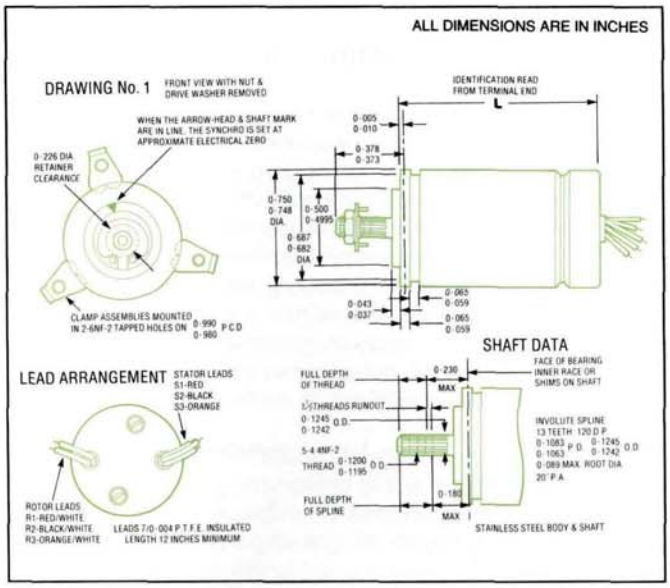
26V 400 Hz
EL 1790

STANDARD HARDWARE SUPPLIED WITH EACH INSTRUMENT		
Item	**Type No·**	**Detail Ref·**
Clamp Assembly	F500/33	A+B
Shaft Nut	F500/37	A †
Drive Washer (Aluminium)	F500/38A	A †

† SUPPLIED EXCEPT PLAIN SHAFT TYPES

AMBIENT TEMPERATURE RANGE:
-65°C + 150°C

Weight 50g (1.75 oz)
Rotor Inertia 1.1g cm² (0·006 oz in²)
Friction Torque 2.9g cm (0·04 oz in)
(Not applicable to Torque Receivers)



SYNCHRO FUNCTION	Drawing & Hardware Detail Ref·	DESCRIPTION TYPE DESIGNATION Military	Muirhead	NATO NUMBER 5990-99-	MILITARY SPECIFICATION	LENGTH (Dim·L) in inches max*	PRIMARY TERMINALS	RATED VOLTS Volts	Amps max	NO LOAD INPUT Watts max	Ohms nom	D.C. RESISTANCE
CONTROL TRANSFORMER	1-A	26V08CX4(B1)	08M1C1	947-3051	EL 1790	1·350	R1 R2 (ROTOR)	26	26	0·111	0·95	60
CONTROL TRANSFORMER	1-A	26V08CT4(B1)	08M2C1	947-3052	EL 1790	1·350	S1 S2 S3 (STATOR)	11·8	10·2	0·137	0·47	28
TORQUE RECEIVER TRANSMITTER	1-A		08M4A1	520-8549	—	1·350	R1 R2 (ROTOR)	26	26	0·3	3·2	26

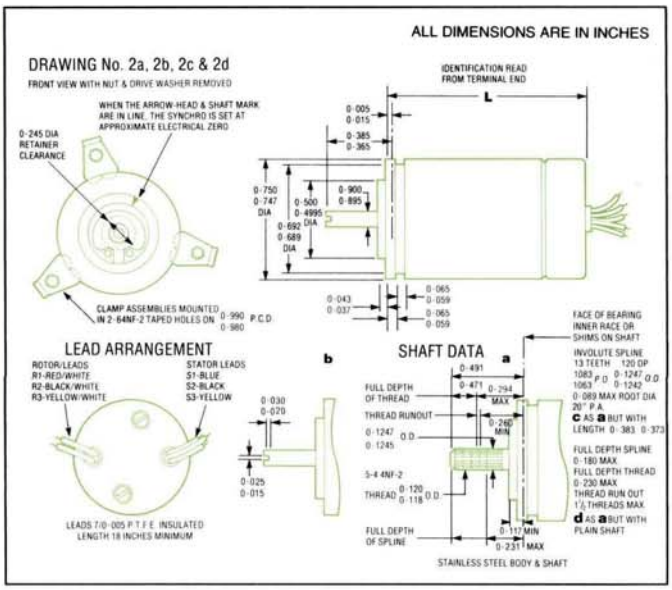
SYNCHRO FUNCTION	Drawing & Hardware Detail Ref·	DESCRIPTION TYPE DESIGNATION Military	Muirhead	NATO NUMBER 5990-99-	MILITARY SPECIFICATION DEP STAN 59-27-2	MIL-S 20708/	LENGTH (Dim·L) in inches max	PRIMARY TERMINALS	RATED VOLTS	Volts	NO LOAD INPUT Amps max	Watts max	D.C. RESISTANCE Ohms nom
CONTROL TRANSMITTERS	2a-A	* 26V08CX4b	08M1G1	972-7610	—	78A	1·240	R1 R2 (ROTOR)	26	26	0·153	0·86	27
		* 26V08CX4C	08M51C1	014-9848	078	78D			26	26	0·153	0·86	27
	2b-B	26V08CX4c	08M1H1	519-5637	DEF148/78	78C			26	26	0·153	0·86	27
	2d-B		08M1P1	199-7029	—	—			26	26	0·153	0·86	27
	2d-B		08M1X1		—	—			115	115	0·070	2·4	375
CONTROL DIFFERENTIAL TRANSMITTERS	2b-B	* 26V08CDX4C	08M3N1	014-9850	080	80D	1·240	S1 S2 S3 (STATOR)	11·8	10·2	0·108	0·3	25
		26V08CDX4C	08M3D1	519-5636	DEF148/80	80C			11·8	10·2	0·108	0·3	25
CONTROL TRANSFORMERS	2a-A	* 26V08CT4b	08M2G1	972-7611	—	79A	1.240	S1 S2 S3 (STATOR)	11·8	10·2	0·023	0·057	104
	2b-B	* 26V08CT4C	08M52L1	014-9849	079	79D			11·8	10·2	0·023	0·057	104
	2b-B	26V08CT4c	08M2H1	519-5635	DEF148/79	79C			11·8	10·2	0·023	0·057	104
	2d.B		08M2T1	199-7030		—			11·8	10·2	0·023	0·057	104
TORQUE RECEIVER TRANSMITTERS	2b-B		08M4L1	712-0795		—	1.240	R1 R2 (ROTOR)	26	26	0·3	2	15·3
	2c-A		08M4C1		—	—			115	115	0·070	2·4	375

26V & 115V, 400Hz MIL-S-20708 DEF 148 DEF—STAN 59-27 PART 2

AMBIENT TEMPERATURE RANGE:
-55°C to + 125°C

* Denotes that the Synchro is on the British Qualified products list to specification DEF STAN 59-27 (PART 2). It is also certified as conforming to NATO Electronics Parts Recommendations for Standardisation of Synchros (N.E.P.R. No. 22) which refers to USA Specification MIL-S-20708C. It is preferred for military applications. Qualification is subject to renewal every four years.

Weight 45g (1·6 oz)
Rotor Inertia 0·8g cm² (0·0045 oz in²)
Friction Torque 2·9g cm (0·04 oz in)
(Not applicable to Torque Receivers)



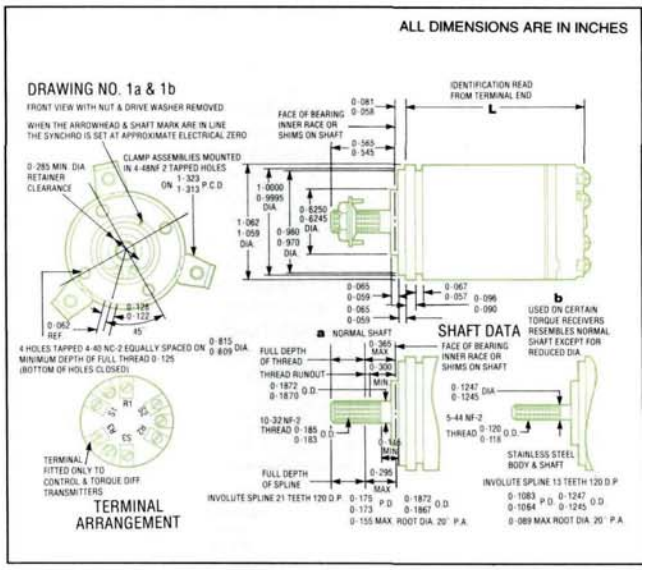
TERMINALS	SECONDARY NO LOAD OUTPUT Volts	Phase lead	VOLTAGE GRADIENT Volts/deg	D.C RESISTANCE Ohms nom	NOMINAL IMPEDENCE ohms Zro	Zrs	Zso	PERFORMANCE ERROR mins Stator	Rotor	Receiver	mV RESIDUAL Fund	Total	MINIMUM TORQUE GRADIENT g cm · oz in	MAXIMUM CONTINUOUS torque g cm	displace-ment deg	PULL-OUT TORQUE g cm	SYNCHRO-NISING TIME secs 30°	C 175°
S1 S2 S3 (STATOR)	11·8	13		19	77+j270	137+j39	17+j49	10			20	40						
R1 R2 (ROTOR)	22·5	13·5	0·39	145	173+j564	253+j104	25+j93	10			30	60						
S1 S2 S3 (STATOR)	11·8	18		8·5	36+j88		8+j20	10		120	Not Applicable		0·2 0·0028	6	23	12	1	2

TERMINALS	SECONDARY NO LOAD OUTPUT Volts	Phase lead	VOLTAGE GRADIENT Volts/deg	D.C RESISTANCE Ohms nom	NOMINAL IMPEDANCE ohms Zro	Zrs	Zso	Zss	PERFORMANCE ERROR mins Stator	Rotor	Receiver	Fund	mV RESIDUAL Total	MINIMUM TORQUE GRADIENT Per degree g cm	oz in	SYNCHRO-NISING TIME secs. 30°	C 175°
S1 S2 S3 (STATOR)	11·8	8		10·8	32+j185	70+j23	9+j32	12·5+j2·7	7			20	30				
	11·8	8		10·8	32+j185	70+j23	9+j32	12·5+j2·7	7			20	30				
	11·8	8		10·8	32+j185	70+j23	9+j32	12·5+j2·7	7			20	30				
	11·8	8		10·8	32+j185	70+j23	9+j32	12·5+j2·7	7			20	30				
	11·8	12		6·5	500+j1890		6·5+j17	86+j1·8	7			30	60				
R1 R2 R3 (ROTOR)	11·8	9·5		34	33+j124	46+j14	24+j108	39+j14	7	7		20	30				
	11·8	9·5		34	33+j124	46+j14	24+j108	39+j14	7	7		20	30				
R1 R2 (ROTOR)	22·5	8·5	0·39	440	607+j2900	800+j300	100+j506	140+j53				25	30				
	22·5	8·5	0·39	440	607+j2900	800+j300	100+j506	140+j53	7			25	30				
	22·5	8·5	0·39	440	607+j2900	800+j300	100+j506	140+j53	7			25	30				
	22·5	8·5	0·39	440	607+j2900	800+j300	100+j506	140+j53	7			25	30				
S1 S2 S3 (STATOR)	11·8	10·5		6·5	20+j92		6·5+j17	86+j1·8	10		120		Not applicable	0·37	0·005	2	4
	11·8	12		6·5	500+j1890		6·5+j17	86+j1·8	10		120		Not applicable	0·32	0·004	2	4

26V & 115V, 400Hz
MIL-S-20708
DEF 148
DEF-STAN
59-27 (PART 2)

AMBIENT
TEMPERATURE RANGE:
-55°C to +125°C

Weight 120g (4·2 oz)
Rotor Inertia 2·6g cm² (0·014 oz in²)
Friction Torque 3·6g cm (0·05 oz in)
(Not applicable to Torque Receivers)



	SYNCHRO FUNCTION	Drawing & Hardware Detail Ref·	DESCRIPTION TYPE DESIGNATION Military	Muirhead	NATO NUMBER 5990-99-	MILITARY SPECIFICATION DEF STAN 59-27(2)	MIL-S 20708/	LENGTH (Dim·L) in inches max	TERMINALS	PRIMARY RATED VOLTS	NO LOAD INPUT Volts	Amps max	Watts max	D.C. RESISTANCE Ohms nom
26V	CONTROL TRANSMITTERS	1a-A	26V11CX4b	11M1G2	519-5600 580-7649	DEF 148/8 —	8A	1·732	R1 R2 (ROTOR)	26	26	0·130	0·56	21·2
		1a-C	* 26V11CX4C	11M1X2	014-9804	008	8C			26	26	0·130	0·56	21·2
	CONTROL DIFFERENTIAL TRANSMITTERS	1a-A	26V11CDX4b	11M3B3	519-5602 580-9000	DEF 148/9 —	9A	1·789	S1 S2 S3 (STATOR)	11·8	10·2	0·150	0·34	10·4
		1a-C	* 26V11CDX4C	11M3M2	014-9805	009	9C			11·8	10·2	0·150	0·34	10·4
	† CONTROL TRANSFORMERS	1a-A	26V11CT4c	11M2G2	519-5595 972-6660	DEF 148/7 —	7A	1·732	S1 S2 S3 (STATOR)	11·8	10·2	0·086	0·18	17·0
		1a-C	* 26V11CT4D	11M52A2	014-9803	007	7C			11·8	10·2	0·086	0·18	17·0
	TORQUE TRANSMITTERS	1a-A	26V11TX4b	11M9D2	519-5598 972-6650	DEF 148/6 —	6A	1·732	R1 R2 (ROTOR)	26	26	0·280	1·10	7·7
		1a-C	* 26V11TX4C	11M9Y2	014-9802	006	6D			26	26	0·280	1·00	7·7
	TORQUE DIFFERENTIAL TRANSMITTER	1a-A		11M5A2		—	—	1·789	S1 S2 S3 (STATOR)	11·8	10·2	0·375	1·00	4·7
	TORQUE RECEIVERS	1b-B	26V11TR4b	11M4E2	519-5597 972-6676	DEF 148/5 —	5A	1·732	R1 R2 (ROTOR)	26	26	0·280	1·10	7·7
		1a-C	* 26V11TR4C	11M4N2	014-9801	005	5C			26	26	0·280	1·00	7·7

	SYNCHRO FUNCTION	Drawing & Hardware Detail Ref·	DESCRIPTION TYPE DESIGNATION Military	Muirhead	NATO NUMBER 5990-99-	MILITARY SPECIFICATION DEF STAN 59-27(2)	MIL-S 20708/	LENGTH (Dim·L) in inches max	TERMINALS	PRIMARY RATED VOLTS	NO LOAD INPUT Volts	Amps max	Watts max	D.C. RESISTANCE Ohms nom
115V	CONTROL TRANSMITTERS	1a-A	11CX4c	11M1G1	519-5601 972-6651	DEF 148/2 —	2A	1·732	R1 R2 (ROTOR)	115	115	0·031	0·61	320
		1a-C	* 11CX4E	11M1X1	014-9807	002	2C			115	115	0·031	0·61	320
	CONTROL DIFFERENTIAL TRANSMITTERS	1a-A	11CDX4a	11M3B2	519-5603 972-7576	DEF 148/81	81A	1·789	S1 S2 S3 (STATOR)	90	78	0·049	0·73	200
		1a-C	* 11CDX4B	11M3M1	014-9811	081	81C			90	78	0·049	0·73	200
	† CONTROL TRANSFORMERS	1a-A	11CT4c	11M2G1	519-5594 972-7619	DEF 148/1 —	1A	1·732	S1 S2 S3 (STATOR)	90	78	0·018	0·29	600
		1a-C	* 11CT4E	11M52A1	014-9806	001	1D			90	78	0·018	0·31	600
	TORQUE TRANSMITTERS	1a-A	11TX4b	11M9D1	519-5599 972-6670	DEF 148/4 —	4A	1·732	R1 R2 (ROTOR)	115	115	0·060	1·10	160
		1a-C	* 11TX4C	11M9Y1	014-9810	004	4C			115	115	0·060	1·00	160
	TORQUE DIFFERENTIAL TRANSMITTER	1a-A		11M5A1		—	—	1·789	S1 S2 S3 (STATOR)	90	78	0·09	1·50	135
	TORQUE RECEIVERS	1b-B	11TR4b	11M4E1	519-5596 972-6675	DEF 148/3 —	3A	1·732	R1 R2 (ROTOR)	115	115	0·060	1·10	160
		1a-C	* 11TR4C	11M4N1	014-9809	003	3C			115	115	0·060	1·00	160

STANDARD HARDWARE SUPPLIED WITH EACH INSTRUMENT

Item	Type No·	Detail Ref
Clamp Assembly	F500/1	A-B-C
Shaft Nut	F500/11	A-C
Shaft Nut (Small shaft)	F500/37	B
Drive Washer (Aluminium)	F500/10A	A
Drive Washer (Brass)	F500/10B	C
Drive Washer (Small shaft)	F500/38A	B
Terminal Lug	F3384	A-B-C

* Denotes that the Synchro is on the British Qualified products list to specification DEF STAN 59-27 (PART 2). It is also certified as conforming to NATO Electronics Parts Recommendations for Standardisation of Synchros (N.E.P.R. No. 22) which refers to USA Specification MIL-S-20708C. It is preferred for defence applications. Qualification is subject to renewal every four years.

† The voltage gradient for Control Transformers is 0 · 39 volt/degree (26V) and 1 · 0 volt/degree (115V).

SECONDARY								PERFORMANCE												
TERMINALS	NO LOAD OUTPUT Volts	Phase lead	D.C. RESISTANCE Ohms nom	NOMINAL IMPEDANCE ohms Zro	Zrs	Zso	Zss	ERROR mins Stator	Rotor	Receiver	mV RESIDUAL Fund	Total	MINIMUM TORQUE GRADIENT Fund g cm	degree oz in	MAXIMUM CONTINUOUS Torque g cm	displace-ment deg	PULL-OUT TORQUE g cm	SYNCHRO-NISING TIME secs 30° - 175°	
S1 S2 S3 (STATOR)	11·8	4·5	7·1	34+j265	51+j21	7·7+j45	8·7+j3·2	7			12	19							
	11·8	4·5	7·1	34+j265	51+j21	7·7+j45	8·7+j3·2	7			12	19							
R1 R2 R3 (ROTOR)	11·8	5·7	15·9	17·6+j86	20·7+j8·7	12·2+j75	17·5+j8·5	10	10		17	26							
	11·8	5·7	15·9	17·6+j86	20·7+j8·7	12·2+j75	17·5+j8·5	7	7		17	26							
R1 R2 (ROTOR)	22·5	6	80	130+j716	151+j73·5	20+j128	27+j13·8	7			15	18							
	22·5	6	80	130+j716	151+j73·5	20+j128	27+j13·8	7			15	18							
S1 S2 S3 (STATOR)	11·8	3·8	2·9	13·7+j114	19·4+j8·7	3·1+j1·3	3·3+j1·3	7					0·61	0·0085	25	38	40		
	11·8	3·8	2·9	13·7+j114	19·4+j8·7	3·1+j19·4	3·3+j1·3	7					0·55	0·008	25	38	40		
R1 R2 R3 (ROTOR)	11·8	6·5	6·3			6·75+j30		10	10				0·3	0·0042					
S1 S2 S3 (STATOR)	11·8	3·8	2·9	13·7+j114	19·4+j8·7	3·1+j19·4	3·3+j1·3	7		60			0·61	0·0085	25	38	40	1·5	2·5
	11·8	3·8	2·9	13·7+j114	19·4+j8·7	3·1+j19·4	3·3+j1·3			60			0·58	0·0085	25	38	40	1	2

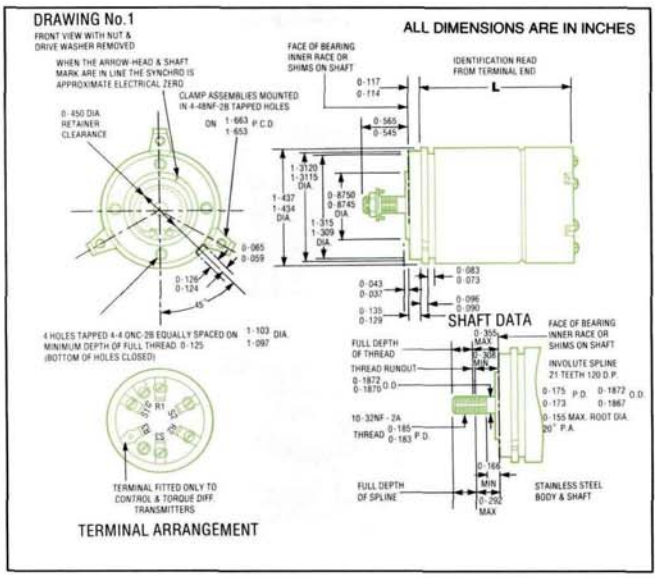
SECONDARY								PERFORMANCE												
TERMINALS	NO LOAD OUTPUT Volts	Phase lead	D.C. RESISTANCE Ohms nom	NOMINAL IMPEDANCE ohms Zro	Zrs	Zso	Zss	ERROR mins Stator	Rotor	Receiver	mV RESIDUAL Fund	Total	MINIMUM TORQUE GRADIENT Fund g cm	degree oz in	MAXIMUM CONTINUOUS Torque g cm	displace-ment deg	PULL-OUT TORQUE g cm	SYNCHRO-NISING TIME secs 30° - 175°	
S1 S2 S3 (STATOR)	90	4·5	348	550+j4070	725+j307	330+j2080	387+j147	7			45	75							
	90	4·5	348	550+j4070	725+j307	330+j2080	387+j147	7			45	75							
R1 R2 R3 (ROTOR)	90	4·7	450	450+j1930	487+j200	242+j1690	421+j211	10	10		59	94							
	90	4·7	450	450+j1930	487+j200	242+j1690	421+j211	7	7		60	90							
R1 R2 (ROTOR)	57·3	4·5	350	510+j3020	535+j302	700+j4900	900+j515	7			30	60							
	57·3	4·5	350	510+j3020	535+j302	700+j4900	900+j515	7			32	60							
S1 S2 S3 (STATOR)	90	6	135	285+j2140	370+j159	175+j1090	191+j76	7					0·61	0·0085	25	38	40		
	90	6	135	285+j2140	370+j159	175+j1090	191+j76	7					0·61	0·0080	25	38	40		
R1 R2 R3 (ROTOR)	90	6	310			180+j1030		10	10				0·3	0·0042					
S1 S2 S3 (STATOR)	90	6	135	285+j2140	370+j159	175+j1090	191+j76	7		60			0·61	0·0085	25	38	40	1·5	2·5
	90	6	135	285+j2140	370+j159	175+j1090	191+j76			60			0·58	0·0080	25	38	40	1	2

26V & 115V, 60Hz & 400 Hz MIL-S-20708 DEF 148 DEF-STAN 59-27 (PART 2)

AMBIENT TEMPERATURE RANGE:
-55°C to +125°C
**-55°C to +150°C

400 Hz: Weight 200g (7 oz)
Rotor Inertia 10g cm² (0·055 oz in²)
Friction Torque 3·6g cm (0·05 oz in)
(Not applicable to Torque Receivers)

60 Hz: Weight: 340g (12 oz)
Rotor Inertia 22g cm² (0·12oz in²)
Friction Torque 3·6g cm (0·05oz in)
(Not applicable to Torque Receivers)
15M9D1 & 15M9E1 22g cm (0.3oz in)



	SYNCHRO FUNCTION	Drawing & Hardware Detail Ref	DESCRIPTION TYPE DESIGNATION Military	Muirhead	NATO NUMBER 5990-99-	MILITARY SPECIFICATION DEF STAN 59-27(2)	MIL-S 20708/	LENGTH (Dim·L) in inches max·	PRIMARY TERMINALS	RATED VOLTS	Volts	NO LOAD INPUT Amps max	Watts max	D.C. RESISTANCE Ohms nom
400 Hz	CONTROL TRANSMITTERS	1-A	15CX4b	15M1G1	519-5608	DEF 148/14		1·640	R1 R2 (ROTOR)	115	115	0·082	1·41	96
					972-6686	—	14A							
		1-B	* 15CX4D	15M1V1	014-9812	014	14E			115	115	0·085	1·41	96
	CONTROL DIFFERENTIAL TRANSMITTERS	1-A	15CDX4b	15M3B1	519-5610	DEF 148/16			S1 S2 S3 (STATOR)	90	78	0·090	1·60	108
					972-6666	—	16A							
		1-B	* 15CDX4D	15M3H1	014-9815	016	16D	1·640		90	78	0·090	1·34	108
	† CONTROL TRANSFORMERS	1-A	15CT4b	15M2E1	519-5605	DEF 148/15			S1 S2 S3 (STATOR)	90	78	0·010	0·200	820
					972-6661	—	15A							
		1-B	* 15CT4C	15M2P1	014-9814	015	15E	1·640		90	78	0·010	0·200	820
		1-B	15CT4c	15M2H1		—	15D			90	78	0·010	0·200	820
	TORQUE TRANSMITTER	1-A	15TX4b	15M9C1	972-6671	See Note 1		1·640	R1 R2 (ROTOR)	115	115	0·200	3·1	40
	TORQUE DIFFERENTIAL TRANSMITTERS	1-A	15TDX4b	15M5B1	519-5612	DEF 148/17			S1 S2 S3 (ROTOR)	90	78	0·215	3·5	40
					972-6679	—	17A	1·640						
		1-B	* 15TDX4C	15M5D1	014-9816	017	17D	1·640		90	78	0·215	3·5	40
	TORQUE RECEIVERS	1-A	15TR4C	15M4D1	972-0182	DEF 148/19	19A		R1 R2 (ROTOR)	115	115	0·19	3·4	40
		1-A		15M4D2	523-3862	—	—	1·640		26	26	0·90	3·25	2·15

	SYNCHRO FUNCTION	Drawing & Hardware Detail Ref·	DESCRIPTION TYPE DESIGNATION Military	Muirhead	NATO NUMBER 5990-99-	MILITARY SPECIFICATION DEF STAN 59-27(2)	MIL-S 20708/	LENGTH (Dim·L) in inches max·	PRIMARY TERMINALS	RATED VOLTS	Volts	NO LOAD INPUT Amps max	Watts max	D.C. RESISTANCE Ohms nom
60 Hz	CONTROL TRANSMITTER	1-A	15CX6b	15M1H1	972-7593	—	20A	2·391	R1 R2 (ROTOR)	115	115	0·56	2·4	550
	CONTROL DIFFERENTIAL TRANSMITTER	1-A	15CDX6b	15M3G1		DEF 148/22		2·391	S1 S2 S3 (STATOR)	90	78	0·038	0·63	500
	† CONTROL TRANSFORMER	1-A	15CT6b	15M2N1		DEF 148/21		2·391	S1 S2 S3 (STATOR)	90	78	0·013	0·21	1300
	TORQUE TRANSMITTERS	1-A	See Note 1	15M9D1						See Note 2				
		1-A	See Note 1	15M9E1 **		See Note 1		2·391	R1 R2 (ROTOR)	115	115	0·2	1·7	450
		1-A	See Note 1	15M9F1						115	115	0·2	1·7	450
	TORQUE RECEIVER	1-A	15TR6a	15M4H1	972-0183	DEF 148/23	23A	2·391	R1 R2 (ROTOR)	115	115	0·2	3·1	400

STANDARD HARDWARE ITEMS NORMALLY SUPPLIED WITH EACH INSTRUMENT

Item	Type No ·	Detail Ref
Clamp Assembly	F500/1	A-B
Shaft Nut	F500/11	A-B
Drive Washer (Aluminium)	F500/10A	A
Drive Washer (Brass)	F500/10B	B
Terminal Lug	F3090	A-B

* Denotes that the Synchro is on the British Qualified products list to specification DEF STAN 59-27 (PART 2). It is also certified as conforming to NATO Electronics Parts Recommendations for Standardisation of Synchros (N.E.P.R. No. 22) which refers to USA Specification MIL-S-20708C. It is preferred for defence applications. Qualification is subject to renewal every four years.
† Voltage Gradient for Control Transformers is 1 volt/degree.

SPECIAL NOTES

NOTE 1: 15M9C1, 15M9D1 and 15M9E1 are basically designed to MIL-S-20708A. 15M9D1 & E1 are suitable for atomic reactor use as control rod indicator transmitters in ambients up to 150°C and regions of limited radio activity. 15M9F1 is basically designed to MIL-S-20708A and is intended for use as a transmitter with 15TR6a.
NOTE 2: Details as for 15M9E1, but spiral ligaments limiting rotation to 450°.

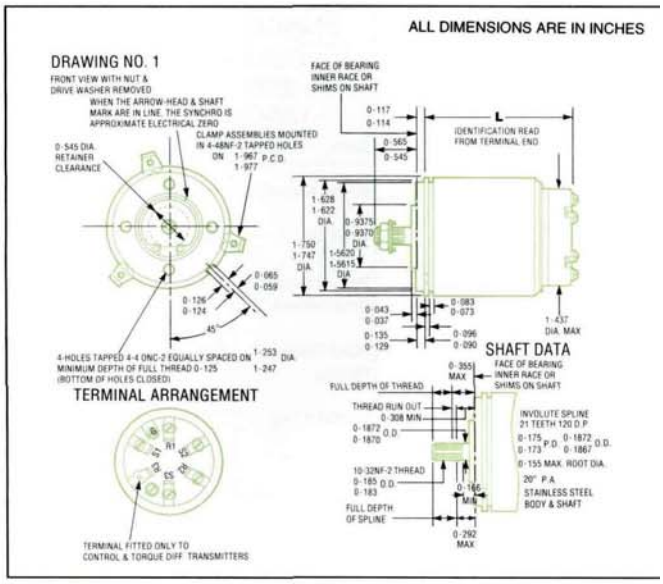
	SECONDARY							PERFORMANCE										
	NO LOAD OUTPUT		D.C. RESISTANCE	NOMINAL IMPEDANCE ohms				ERROR mins			mV RESIDUAL		MINIMUM TORQUE GRADIENT		MAXIMUM CONTINUOUS		PULL-OUT TORQUE	SYNCHRONISING TIME secs 30° - 175°
TERMINALS	Volts	Phase lead	Ohms nom	Zro	Zrs	Zso	Zss	Stator	Rotor	Receiver	Fund	Total	Fund g cm	degree oz in	Torque g cm	displacement deg	g cm	
S1 S2 S3 (STATOR)	90	3·6	83	179+j1400	217+j125	100+j775	112+j63	6			40	90						
	90	3·6	83	179+j1400	217+j125	100+j775	112+j63	6			32	60						
R1 R2 R3 (ROTOR)	90	5·2	139	159+j1060	190+j125	129+j917	164+j111	6	6		60	90						
	90	5·2	139	159+j1060	190+j125	129+j917	164+j111	6	6		32	60						
R1 R2 (ROTOR)	57·3	4·2	530	837+j5170	943+j589	1020+j8330	1500+j982	6			40	60						
	57·3	4·2	530	837+j5170	943+j589	1020+j8330	1500+j982	6			32	60						
	57·3	4·2	530	837+j5170	943+j589	1020+j8330	1500+j982	6			32	60						
S1 S2 S3 (STATOR)	90	2·5	42	100+j955	96+j68	65+j493	48+j33	6			120	220	2·2	0·03	22	10	85	
R1 R2 R3 (ROTOR)	90	4·0	94	100+j503	107+j62	50+j418	88+j60	8	8		—	—	0·79					
	90	4·0	94	100+j503	107+j62	50+j418	88+j60	8	8		—	—	0·79	0·011				
S1 S2 S3 (STATOR)	90	5·0	42	100+j995	96+j68	65+j493	48+j33	6		45	—	—	2·2	0·03	22	10	85	1 2
	11·8	4·0	0·83	5+j47	—	1·1+j8·3	0·9+j0·4	6		45	—	—	1.70	0·23	22	10	85	1 2

	SECONDARY							PERFORMANCE										
	NO LOAD OUTPUT		D.C. RESISTANCE	NOMINAL IMPEDANCE ohms				ERROR mins			mV RESIDUAL		MINIMUM TORQUE GRADIENT		MAXIMUM CONTINUOUS		PULL-OUT TORQUE	SYNCHRONISING TIME secs 30° - 175°
TERMINALS	Volts	Phase lead	Ohms nom	Zro	Zrs	Zso	Zss	Stator	Rotor	Receiver	Fund	Total	Fund g cm	degree oz in	Torque g cm	displacement deg	g cm	
S1 S2 S3 (STATOR)	90	15	470	628+j2210	1170+j299	367+j1190	630+j143	7			75	110						
R1 R2 R3 (ROTOR)	90	10	940	780+j2625	1114+j270	435+j2270	930+j830	8	8		75	125						
R1 R2 (ROTOR)	57·3	9·0	900	970+j3800	1430+j409	1140+j6240	2280+j836	6			60	90						
S1 S2 S3 (STATOR)	90	14	390	500+j2000	800+j180	300+j1300	450+j100	10			—	—	2.2	0·03	70	33	95	
	90	14	390	500+j2000	800+j180	300+j1300	450+j100	6			—	—	2·2	0·03	70	33	95	
S1 S2 S3 (STATOR)	90	14	350	502+j2240	885+j194	301+j1400	509+j106	6		45	—	—	2·2	0·03	70	33	95	1 2

115V
60Hz & 400 Hz
MIL-S-20708
DEF-STAN
59-27 (PART 2)

AMBIENT
TEMPERATURE RANGE:
-55°C to +125°C

Weight 400g (14 oz)
Rotor Inertia 29g cm² (0·16 oz in²)
Friction Torque 3·6g cm (0·05 oz in)
(Not applicable to Torque Receivers)



	SYNCHRO FUNCTION	Drawing & Hardware Detail Ref·	DESCRIPTION TYPE DESIGNATION Military	Muirhead	NATO NUMBER 5990-99-	MILITARY SPECIFICATION DEF STAN 59-27(2)	MIL-S 20708/	LENGTH (Dim·L) in inches max·	TERMINALS	PRIMARY RATED VOLTS	Volts	NO LOAD INPUT Amps max	Watts max	D.C. RESISTANCE Ohms nom
400 Hz	CONTROL TRANSMITTERS	1-A	18CX4b	18M1B2	519-5614 972-6687	DEF 148/28 —	28A	2·388	R1 R1 (ROTOR)	115	115	0·11	1·32	25
		1-B	* 18CX4d	18M1C1		—	28C			115	115	0·11	1·32	25
		1-B	* 18CX4D	18M1D1	014-9822	028	28D			115	115	0·11	1·32	25
	CONTROL DIFFERENTIAL TRANSMITTERS	1-A	18CDX4b	18M3B1	519-5618 972-6667	DEF 148/30 —	30A	2·388	S1 S2 S3 (STATOR)	90	78	0·128	1·21	50
		1-B	* 18CDX4C	18M3D1	014-9825	030	30D			90	78	0·128	1·21	50
	† CONTROL TRANSFORMERS	1-A	18CT4b	18M2B2	519-5616 972-6662	DEF 148/29 —	29A	2·388	S1 S2 S3 (STATOR)	90	78	0·0065	0·07	850
		1-B	* 18CT4e	18M2C1		—	29C			90	78	0·0070	0·07	850
		1-B	* 18CT4C	18M2E1	014-9824	029	29D			90	78	0·0070	0·07	850
	TORQUE DIFFERENTIAL TRANSMITTER	1-B	* 18TDX4C	18M5C1	014-9826	031	31D	2·388	S1 S2 S3 (STATOR)	90	78	0·45	4·5	11
	TORQUE RECEIVERS TRANSMITTERS	1-A	18TR4b	18M4F1	972-6677	DEF 148/32 —	32A	2·388	R1 R2 (ROTOR)	115	115	0·43	4·0	9·5
		1-B	18TRX4a	18M4L1	547-0891	—	32E			115	115	0·40	4·0	9·5

	SYNCHRO FUNCTION	Drawing & Hardware Detail Ref·	DESCRIPTION TYPE DESIGNATION Military	Muirhead	NATO NUMBER 5990-99-	MILITARY SPECIFICATION DEF STAN 59-27(2)	MIL-S 20708/	LENGTH (Dim·L) in inches max·	TERMINALS	PRIMARY RATED VOLTS	Volts	NO LOAD INPUT Amps max	Watts max	D.C. RESISTANCE Ohms nom
60 Hz	CONTROL TRANSMITTERS	1-A	18CX6b	18M1B1	519-5613 972-6658	DEF 148/33 —	33A	2·388	R1 R2 (ROTOR)	115	115	0·040	1·11	520
		1-B	* 18CX6c	18M1C2		—	33B			115	115	0·040	1·11	520
		1-B	* 18CX6C	18M1D2	014-9828	033	33C			115	115	0·040	1·11	520
	CONTROL DIFFERENTIAL TRANSMITTERS	1-A	18CDX6b	18M3B2	519-5619 972-6668	DEF 148/36 —	36A	2·388	S1 S2 S3 (STATOR)	90	78	0·052	1·45	572
		1-B	* 18CDX6D	18M3D2	014-9831	036	36C			90	78	0·052	1·45	572
	† CONTROL TRANSFORMERS	1-A	18CT6b	18M2B1	519-5617 972-6663	DEF 148/34 —	34A	2·388	S1 S2 S3 (STATOR)	90	78	0·017	0·45	2160
		1-B	* 18CT6D	18M2E2	014-9829	034	34C			90	78	0·017	0·45	2160
	TORQUE TRANSMITTER	1-A	18TX6a	18M9B1	972-6672	DEF 148/37	37A	2·388	R1 R2 (ROTOR)	115	115	0·100	4	245
	TORQUE RECEIVERS TRANSMITTERS	1-A	18TRX6a	18M4E1	972-6683 —		35A	2·388	R1 R2 (ROTOR)	115	115	0·105	4	245
		1-B	18TRX6b	18M4N1		—	35C			115	115	0·105	4	245
		1-A	‡	18M4E2		—				115	115	0·094	5	365

STANDARD HARDWARE ITEMS NORMALLY SUPPLIED WITH EACH INSTRUMENT

Item	Type No·	Detail Ref
Clamp Assembly	F500/1	A-B
Shaft Nut	F500/11	A-B
Drive Washer (Aluminium)	F500/10A	A
Drive Washer (Brass)	F500/10B	B
Terminal Lug	F3090	A-B

* Denotes that the Synchro is on the British Qualified products list to specification DEF STAN 59-27 (PART 2). It is also certified as conforming to NATO Electronics Parts Recommendations for Standardisation of Synchros (N.E.P.R. No. 22) which refers to USA Specification MIL-S-20708C. It is preferred for defence applications. Qualification is subject to renewal every four years.
† The voltage gradient for the Control Transformers is 1 volt/degree.
‡ Designed to operate at 50Hz.

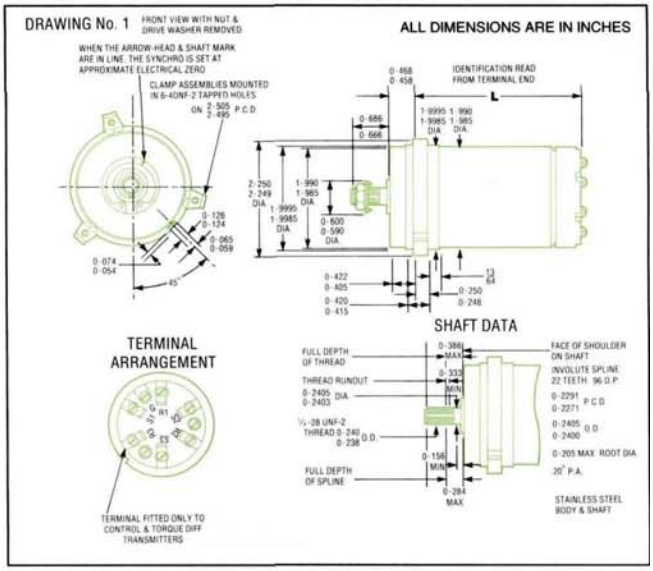
SECONDARY								PERFORMANCE										
TERMINALS	NO LOAD OUTPUT Volts	Phase lead	D.C. RESISTANCE Ohms nom	NOMINAL IMPEDANCE ohms Zro	Zrs	Zso	Zss	ERROR mins Stator	Rotor	Receiver	mV RESIDUAL Fund	Total	MINIMUM TORQUE GRADIENT Per degree g cm	oz in	MAXIMUM CONTINUOUS Torque g cm	displacement deg	PULL-OUT TORQUE g cm	SYNCHRONISING TIME secs 30° - 175°
S1 S2 S3 (STATOR)	90	1	38	78+j1210	78+j81	52+j598	40+j39	6			50	90						
	90	1	38	78+j1210	78+j81	52+j598	40+j39	6			40	60						
	90	1	38	78+j1210	78+j81	52+j598	40+j39	6			40	60						
R1 R2 R3 (ROTOR)	90	3	45	65+j669	72+j71	63+j623	65+j64	6	6		40	75						
	90	3	45	65+j669	72+j71	63+j623	65+j64	6	6		40	75						
R1 R2 (ROTOR)	57·3	2·5	390	800+j7770	745+j782	1360+j12600	1240+j1250	6			30	45						
	57·3	2·5	390	800+j7770	745+j782	1360+j12600	1240+j1250	6			20	30						
	57·3	2·5	390	800+j7770	745+j782	1360+j12600	1240+j1250	6			20	30						
R1 R2 R3 (ROTOR)	90	3	14	20·8+j206	21·1+j22·1	17+j183	18·3+j19·9	8	8		Not applicable		4·3	0·06				
S1 S2 S3 (STATOR)	90	1·5	10·5	25+j370	25+j25	16+j180	12+j12	5		45	Not applicable		7·2	0·1	104	12	455	1 2
	90	1·5	10·5	25+j370	25+j25	16+j180	12+j12	8		45	50	100	7·2	0·1	104	12	455	1 2

SECONDARY								PERFORMANCE										
TERMINALS	NO LOAD OUTPUT Volts	Phase lead	D.C. RESISTANCE Ohms nom	NOMINAL IMPEDANCE ohms Zro	Zrs	Zso	Zss	ERROR mins Stator	Rotor	Receiver	mV RESIDUAL Fund	Total	MINIMUM TORQUE GRADIENT Per degree g cm	oz in	MAXIMUM CONTINUOUS Torque g cm	displacement deg	PULL-OUT TORQUE g cm	SYNCHRONISING TIME secs 30° - 175°
S1 S2 S3 (STATOR)	90	10	623	605+j3130	1380+j451	510+j1580	740+j150	8			65	115						
	90	10	623	605+j3130	1380+j451	510+j1580	740+j150	8			30	85						
	90	10	623	605+j3130	1380+j451	510+j1580	740+j150	8			30	85						
R1 R2 R3 (ROTOR)	90	17	867	717+j1850	1130+j315	465+j1490	885+j308	8	8		80	100						
	90	17	865	717+j1850	1130+j315	465+j1490	885+j308	7	7		60	100						
R1 R2 (ROTOR)	57·3	18	1050	1050+j3280	1880+j611	1690+j4800	2830+j848	6			30	60						
	57·3	18	1050	1050+j3280	1880+j611	1690+j4800	2830+j848	6			25	45						
S1 S2 S3 (STATOR)	90	14	300	335+j1270	686+j210	256+j916	379+j81	6			Not applicable		3·6	0·05	134	37	172	
S1 S2 S3 (STATOR)	90	14	300	335+j1270	686+j210	256+j916	379+j81	6		45	Not applicable		3·6	0·05	134	37	172	1 2
	90	14	300	335+j1270	686+j210	256+j916	379+j81	6		45	50	300	3·6	0·05	134	37	172	1 2
	90	19	475	565+j1200		405+j1120	594+j115	7		60	Not applicable		2·9	0·04				1 2

115V, 60Hz & 400 Hz
MIL-S-20708
DEF 148
DEF-STAN
59-27 (PART 2)

AMBIENT
TEMPERATURE RANGE:
-55°C to +125°C

Weight 850g (30 oz)
Rotor Inertia 130g cm² (0·71 oz in²)
Friction Torque 14g cm (0·2 oz in)
(Not applicable to Torque Receivers)



	SYNCHRO FUNCTION	Drawing & Hardware Detail Ref·	DESCRIPTION TYPE DESIGNATION Military	Muirhead	NATO NUMBER 5990-99-	MILITARY SPECIFICATION DEF STAN 59-27(2)	MIL-S 20708/	LENGTH (Dim·L) in inches max·	TERMINALS	PRIMARY RATED VOLTS	Volts	NO LOAD INPUT Amps max	Watts max	D.C. RESISTANCE Ohms nom
400 Hz	CONTROL TRANSMITTERS	1-A	23CX4b	23M1C1	519-5633 971-7209	DEF 148/45 —	45A	3·160	R1 R2 (ROTOR)	115	115	0·245	2·94	15·5
		1-B	* 23CX4D	23M1H1	014-9832	045	45D			115	115	0·245	2·95	15·5
	CONTROL DIFFERENTIAL TRANSMITTERS	1-A	23CDX4b	23M3B1	519-5622 971-8487	DEF 148/47 —	47A	3·410	S1 S2 S3 (STATOR)	90	78	0·284	2·9	18
		1-B	* 23CDX4C	23M3E1	014-9834	047	47C			90	78	0·285	2·9	18
	† CONTROL TRANSFORMERS	1-A	23CT4b	23M2B1	519-5626 971-8488	DEF 148/46 —	46A	3·160	S1 S2 S3 (STATOR)	90	78	0·0058	0·071	730
		1-B	** 23CT4C	23M2E1	014-9833	046	46C			90	78	0·0057	0·071	730
	TORQUE TRANSMITTERS	1-A	23TX4b	23M9C1	519-5634	DEF 148/44			R1 R2 (ROTOR)	115	115	0·719	6·5	2·8
		1-A		** 23M9C3				3·160		115	115	0·800	4·5	3·4
	TORQUE DIFFERENTIAL TRANSMITTER	1-A		‡ 23M5B1	972-6681	—	—	3·410	S1 S2 S3 (STATOR)	90	78	0·950	5·2	4·3
	TORQUE RECEIVERS	1-A	23TR4b	23M4D1	519-5624	DEF 148/50		3·160	R1 R2 (ROTOR)	115	115	0·719	6·5	2·8
		1-B	* 23TRX4A	23M4F2	014-9836	050	50C			115	115	0·720	4·6	2·8

	SYNCHRO FUNCTION	Drawing & Hardware Detail Ref·	DESCRIPTION TYPE DESIGNATION Military	Muirhead	NATO NUMBER 5990-99-	MILITARY SPECIFICATION DEF STAN 59-27(2)	MIL-S 20708/	LENGTH (Dim·L) in inches max·	TERMINALS	PRIMARY RATED VOLTS	Volts	NO LOAD INPUT Amps max	Watts max	D.C. RESISTANCE Ohms nom
60 Hz	CONTROL TRANSMITTERS	1-A	23CX6c	23M1C2	519-5632 972-6659	DEF 148/52 —	52A	3·160	R1 R2 (ROTOR)	115	115	0·080	1·60	195
		1-B	* 23CX6D	23M1H2	014-9837	052	52C			115	115	0·080	1·74	184
	CONTROL DIFFERENTIAL TRANSMITTERS	1-A	23CDX6b	23M3B2	519-5623 972-6669	DEF 148/54 —	54A	3·410	S1 S2 S3 (STATOR)	90	78	0·090	1·60	255
		1-B	* 23CDX6C	23M3E2	014-9839	054	54C			90	78	0·090	1·82	255
	† CONTROL TRANSFORMERS	1-A	23CT6c	23M2B2	519-5625	DEF 148/53 —	53A	3·160	S1 S2 S3 (STATOR)	90	78	0·0185	0·45	1740
		1-B	* 23CT6D	23M2E2	014-9838	053	53C			90	78	0·0185	0·50	1740
	TORQUE TRANSMITTER	1-A	23TX6b	23M9C2	972-6674	DEF 148/51	51A	3·160	R1 R2 (ROTOR)	115	115	0·23	6·0	74
	TORQUE DIFFERENTIAL TRANSMITTER	1-A	23TDX6b	25M5B2	972-6682	—	55A	3·410	S1 S2 S3 (STATOR)	90	78	0·20	5·0	113
	TORQUE RECEIVER TRANSMITTERS	1-A	23TRX6a	23M4C1	519-5629 972-6684	DEF 148/56 —	56A	3·160	R1 R2 (ROTOR)	115	115	0·23	6·0	74
		1-B	* 23TRX6B	23M4F1	014-9841	056	56C			115	115	0·21	5·6	74

STANDARD HARDWARE ITEMS NORMALLY SUPPLIED WITH EACH INSTRUMENT		
Item	**Type No·**	**Detail Ref**
Shaft Nut	F500/53	A-B
Drive Washer (Aluminium)	F500/32A	A
Drive Washer (Brass)	F500/32B	B
Terminal Lug	F3090	A-B

* Denotes that the Synchro is on the British Qualified products list to specification DEF STAN 59-27 (PART 2). It is also certified as conforming to NATO Electronics Parts Recommendations for Standardisation of Synchros (N.E.P.R. No. 22) which refers to USA Specification MIL-S-20708C. It is preferred for defence applications. Qualification is subject to renewal every four years.
† The voltage gradient for Control Transformers is 1 volt/degree.
** Basically designed to the requirements of MIL-S-20708A.
‡ Basically designed to the requirements of MIL-S-20708A and DEF 148.

SECONDARY								PERFORMANCE												
TERMINALS	NO LOAD OUTPUT Volts	Phase lead	D.C. RESISTANCE Ohms nom	NOMINAL IMPEDANCE ohms Zro	Zrs	Zso	Zss	ERROR mins Stator	Rotor	Receiver	mV RESIDUAL Fund	Total	MINIMUM TORQUE GRADIENT Fund g cm	degree oz in	MAXIMUM CONTINUOUS Torque g cm	displace-ment deg	PULL-OUT TORQUE g cm	SYNCH-RONISING TIME secs 30° - 175°	
S1 S2 S3 (STATOR)	90	1·8	11·8	31+j530	31+j36	15+j263	15·7+j17·7	8			40	60							
	90	1·8	11·8	31+j530	31+j36	15+j263	15·7+j17·7	6			32	48							
R1 R2 R3 (ROTOR)	90	3	19	26+j310	27+j30	24+j280	24·7+j27·2	7	7		40	75							
	90	3	19	26+j310	27+j30	24+j280	24·7+j27·2	7	7		30	60							
R1 R2 (ROTOR)	57·3	2	330	750+j8570	660+j812	1230+j14300	1100+j1360	6			30	60							
	57·3	2	330	750+j8750	660+j812	1230+j14300	1100+j1360	6			20	45							
S1 S2 S3 (STATOR)	90	1	3·7	14+j225	8·7+j11	8·5+j110	4·2+j5·3	6			—	—	18	0·25	290	16	1380		
	90	1	3·0	18+j257	8·8+j12	10+j126	4·3+j5·8	6			75	100	17·3	0·24	275	16	1300		
R1 R2 R3 (ROTOR)	90	2	6·0	10+j120	8·2+j11·7	7·8+j107	7·3+j10·6	8	8				11	0·15					
S1 S2 S3 (STATOR)	90	1	3·7	14+j225	8·7+j11	8·5+j110	4·2+j5·3	6		45	—	—	18	0·25	290	16	1380	1	2
	90	1	3·7	14+j225	8·7+j11	8·5+j110	4·2+j5·3	6		45	30	150	18	0·25	275	16	1380	1	2

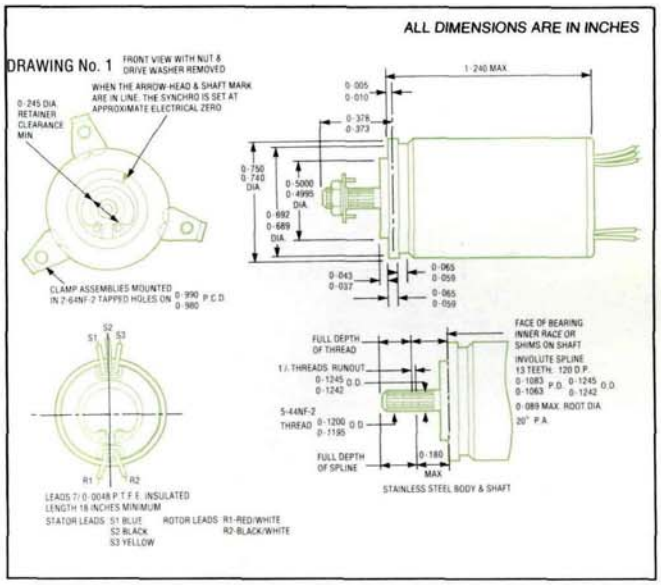
SECONDARY								PERFORMANCE												
TERMINALS	NO LOAD OUTPUT Volts	Phase lead	D.C. RESISTANCE Ohms nom	NOMINAL IMPEDANCE ohms Zro	Zrs	Zso	Zss	ERROR mins Stator	Rotor	Receiver	mV RESIDUAL Fund	Total	MINIMUM TORQUE GRADIENT Fund g cm	degree oz in	MAXIMUM CONTINUOUS Torque g cm	displace-ment deg	PULL-OUT TORQUE g cm	SYNCH-RONISING TIME secs 30° - 175°	
S1 S2 S3 (STATOR)	90	6	276	242+j1650	462+j150	211+j954	319+j62	8			40	75							
	90	6	221	242+j1650	462+j150	211+j954	319+j62	6			30	60							
R1 R2 R3 (ROTOR)	90	11	315		453+j147	214+j947		8	8		65	80							
	90	11	315		453+j147	214+j947		8	8		40	65							
R1 R2 (ROTOR)	57·3	14	800	883+j3080	1500+j512	1380+j4790	2370+j791	6			40	60							
	57·3	14	800	883+j3080	1500+j512	1380+j4790	2370+j791	6			30	45							
S1 S2 S3 (STATOR)	90	7	103	96+j738	210+j63	78+j445	106+j24	8					8·6	0·12	475	44	700		
R1 R2 R3 (ROTOR)	90	11	129	105+j500	181+j62	85+j415	152+j54	6	6				2·2	0·03					
S1 S2 S3 (STATOR)	90	7	103	96+j738	210+j63	78+j445	106+j24	8		45			8·6	0·12	475	44	700	1	2
	90	5	‘ 103	92+j980	218+j66	82+j480	108+j25	8		45	60	160	8·6	0·12	475	44	700	1	2

26V 400Hz

STANDARD HARDWARE SUPPLIED WITH EACH INSTRUMENT	
Item	**Type No.**
Clamp Assembly	F500/33
Shaft Nut	F500/37
Drive Washer (Aluminium)	F500/38A

AMBIENT TEMPERATURE RANGE: -55°C to +125°C

Weight: 48g (1·7 oz)
Friction Torque: 2·9 g cm (0·04 oz in)
Rotor Inertia: 1·0 g cm² (0·0055 oz in²)



SYNCHRO FUNCTION	TYPE DESIGNATION Muirhead	PRIMARY TERMINALS	RATED VOLTS	NO LOAD INPUT Volts	Amps max	Watts max	D.C. RESISTANCE Ohms Nom.	SECONDARY TERMINALS	NO LOAD OUTPUT Volts	Phase lead	D.C. RESISTANCE Ohms nom.	NOMINAL IMPEDANCE Ohms Zro	Zrs	Zso	Zss	PERFORMANCE ERROR mins	mV RESIDUAL Fund	Total
CONTROL TRANSMITTER	08M71A1	R1 R2 (ROTOR)	26	26	0·12	2·2	8·0	S1 S2 S3 (STATOR)	11·8	28	60	160+j215	220+j215	80+j80	92+j13	10	20	30
CONTROL TRANSFORMER	08M72A1	S1 S2 S3 (STATOR)	11·8	10·2	0·027	0·053	62	R1 R2 (ROTOR)	22·5	17	500	1100+j1640	1300+j470	75+j400		14	30	40

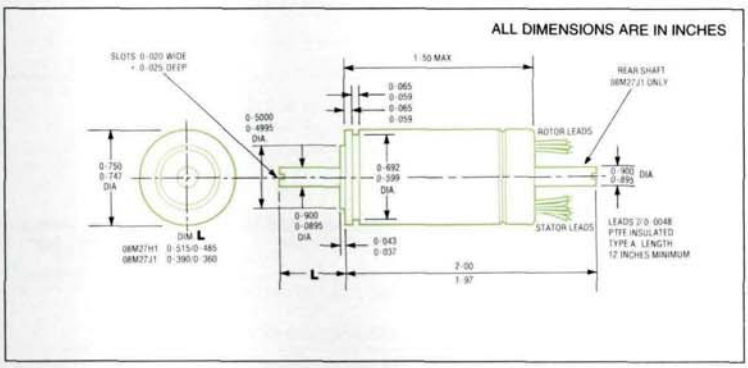
size 08 tandem synchros

400 Hz

STANDARD HARDWARE SUPPLIED WITH EACH INSTRUMENT	
Item	**Type No.**
Clamp Assembly	F500/33

AMBIENT TEMPERATURE RANGE -55°C to 125°C

Weight: 50g 1·7 oz
Friction Torque: 1 g cm. (0·014 oz in)
Rotor Inertia: 1 g cm² (0·0055 oz in²)



SYNCHRO FUNCTION	TYPE DESIGNATION Muirhead	PRIMARY TERMINALS	RATED VOLTS	NO LOAD INPUT Volts	Amps max	Watts max	D.C. RESISTANCE Ohms Nom.	SECONDARY TERMINALS	NO LOAD OUTPUT Volts	Phase lead	D.C. RESISTANCE Ohms nom.	NOMINAL IMPEDANCE Ohms Zro	Zrs	Zso	Zss	PERFORMANCE ERROR mins	mV RESIDUAL Fund	Total
CONTROL TRANSFORMER	08M27H1	(STATOR)	11·8	10·2	0·032	0·070	60	(ROTOR)	22·5	6·5	260	410+j2040	470+j180	60+j370	90+j30	15	40	40
PICK-OFF RESOLVER	08M27J1	(STATOR)	15	15	0·053	0·73	277	(ROTOR)		54	122	130+j130	180+j80	280+j200	370+j120	15*		

* Or 1½% of electrical angle, whichever is greater. Measured over limited angular range of ± 60°

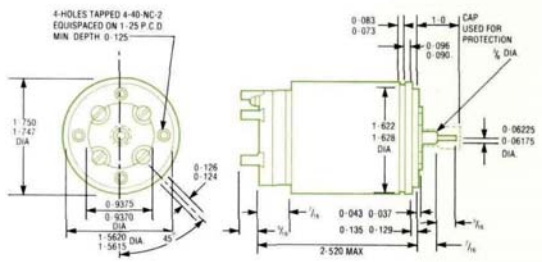
115V
60Hz & 400 Hz

AMBIENT
TEMPERATURE
RANGE:
-55°C to +85°C

STANDARD HARDWARE ITEMS NORMALLY SUPPLIED WITH EACH INSTRUMENT	
Item	**Type No.**
3 Clamp Assemblies	F500/1

Weight 370g (13 oz)
Rotor Inertia 2·7g cm² (0·15 oz in²)

ALL DIMENSIONS ARE IN INCHES



TERMINAL
ARRANGEMENT

TYPE DESIGNATION Muirhead	TYPE DESIGNATION Military	NATO NUMBER 5990-99	PRIMARY ELECTRICAL DATA FREQUENCY Hz	TERMINALS	VOLTAGE Volts	CURRENT Amps	IMPEDANCE Ohms	D.C. RESISTANCE Ohms Nom	SECONDARY ELECTRICAL DATA STATOR VOLTAGE Volts	CURRENT Amps	POWER Watts	IMPEDANCE Ohms	D.C. RESISTANCE Ohms Nom	FOLLOWING ACCURACY Degrees
18R16X	18M23A2	372-7453	60	R1 R2 (ROTOR)	115	0·03	3000+j3800	2500	90	0·03	3·0	3300+j3000	2900	4(spread)
	18M23A1	523-3887	400	R1 R2 (ROTOR)	115	0·03	1500+j3800	410	90	0·03	2·0	2200+j3000	2175	4 (spread)

SPECIAL NOTE

These units are low torque receivers for use with size 18 or 23 control transmitters (see pages 10-13). They are designed for pointer indication only and impose little reaction on the transmitter so that, if a number of receivers are operated from one transmitter and one is restrained, the accuracy of the others is not impaired.

Conversion Table

Parameter	Metric Unit	Multiply by to convert to	Imperial Unit	Divide by to convert	Metric Unit
Length					
	mm	0.03937	Inches	25.40	mm
Weight					
	g	0.035274	oz	28.3495	g
Temperature					
	°C	(°Cx9÷5)+32	°F	(°F-32x5)÷9	°C
Speed					
	rad/s	9.54930	rpm	0.10472	rad/s
Force					
	N	3.59572	oz	0.2781	N
Torque					
	Nm	0.73731	lbft	1.355628	Nm
	Nm	141.5636	ozin	0.00706	Nm
	gcm	0.01388	ozin	72.0461	gcm
Torque Sensitivity					
	Nm/A	0.73731	lbft/A	1.35628	Nm
	Nm/A	141.5636	ozin/A	0.00706	Nm
	gcm/A	0.01388	ozin/A	72.0461	gcm/A
Motor Constant					
	Nm/√W	0.73731	lbft/√W	1.35628	Nm/√W
Damping Factor					
	Nm/rad/s	0.73731	lbft/rad/s	1.35628	Nm/rad/s
Voltage Sensitivity					
	V/rad/s	1	V/rad/s	1	V/rad/s
Rotor Inertia					
	kgm2	23.7303	lbft2	0.04214	Kgm2

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