

Attachment 2 Ground Control Station (GCS)

1. **GCS.** The GCS hardware and software design is modular. It uses a number of control input devices: keyboard, mouse, joystick, rudder pedals, touch screen/touchpad. In the trailer-based GCS there are two redundant operator control/monitoring stations and multiple engineering stations for vehicle monitoring. In the mobile van-based MGCS, there are the same two redundant operator control/monitoring stations and a single engineering station. Both GCS versions receive and monitor the same flight and vehicle health data. The MGCS employs the same screen readouts as the trailer GCS, but does not include the multiple chart recorders. The GCS layout and vehicle controller screen are shown in figures 1 and 2. The engineering station (and, if needed, an operator station) has extensive health-monitoring readouts, as shown in Figure 3, for the numerous sensor points, as well as more detailed screens for specific functions.
2. **Method of pilotage.** The A160 UAS uses a global positioning system (GPS) to navigate from GCS operator input routing or pre-programmed mission plans. The UAS operator can respond in real-time to ATC instructions.
3. **Route and altitude procedures.** After launch, the A160 follows a preprogrammed mission plan or follows position commands input by the operator in the GCS.
4. **Lost link/mission abort procedures.** The GCS maintains a constant uplink/downlink with the A160. If the link signal is not received for a specified length of time, the aircraft performs its lost link protocol, including returning to land at a pre-designated position.

Figure 1, Ground Control Station Layout

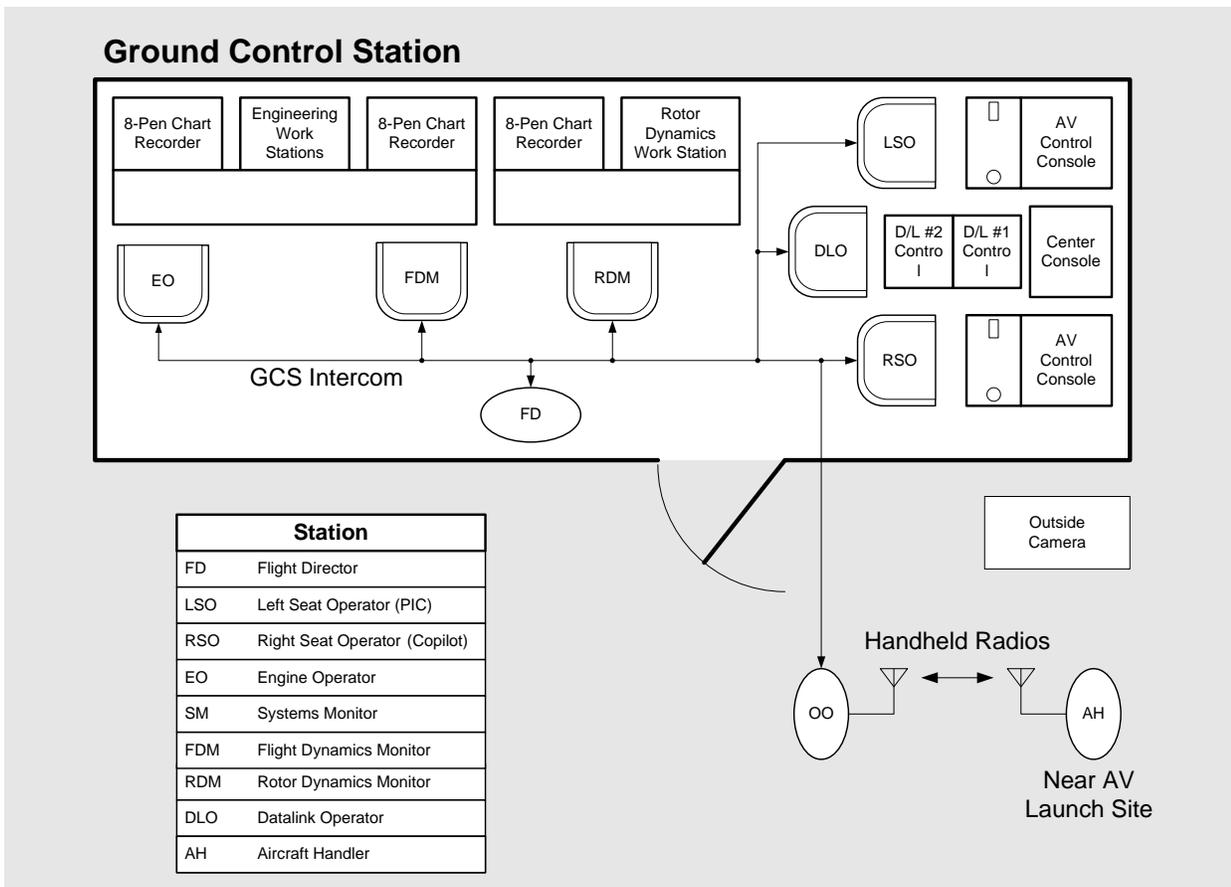


Figure 2, Operator's Console Vehicle Control Screen



Figure 3: Health Monitoring Display Screenshot (typical_

Signal	Value	Signal	Value	Signal	Value	Signal	Value	Signal	Value	Signal	Value	Signal	Value	Signal	Value
=Important=		TailCmd	2.672	FuelLevel3Sens	0.360	RPMMax	400.000	MRAct3AmpSens	0.362	ParlModeOff	0	MiscStatus10	1213	CStrain2_1	7434
MRRPMSens	280...	TRTorqueSens1	160...	FuelLevel4Sens	5.740	RPMMin	80.000	TRActAmpSens	2.147	NavLights	0	val1	-0.130	CStrain2_2	7882
EngRPMsSens	5540...	TRPitchLinkStrainSens1	139...	FuelLevelTotal	37.540	FwdVelocWindComp	0.000	RudderActAmp...	0.117	StrobeLights	0	val2	-66.883	CStrain2_3	7840
EngTorqueSens	86.640	TRLag3StrainSens1	120...	EngFuelPump1Cmd	1	RgtVelocWindComp	0.000	LeftBrakeSens1	-0.0	LandLights	0	val3	0.000	CStrain3_0	0
EngManifoldPressSens	7.154	TRFlap3StrainSens1	100...	EngFuelPump2Cmd	0	CmdSpare1	0.000	RightBrakeSens	-0.0	PowerInternal	0	val4	7.088	CStrain3_1	0
EngOilPressSens	88.660	TRGBoxOilTempSens	115...	EngFuelPump3Cmd	0	CmdSpare2	0.000	LeftBrakeCmd	0.000	Extinguisher...	0	val5	4.289	CStrain3_2	0
EngOilOutTempSens	200....	TRPinionBearingTempSens	123.5	EngFuelPump4Cmd	0	=Avionics & Po...		RightBrakeCmd	0.000	FuelStrategy	0	val6	0.277	CStrain3_3	0
EngOilInletTempSens	174....	=Vibration=		EngFuelValve1Cmd	1	SysBusVolts12Sens	13.2	MRAct1PosCmd	-0.125	FuelPumpOn	0x00	val8	0.000	MMonFwd0	-76.671
val70lByPassFlow	4.181	Accel_0TailZ	-0.301	EngFuelValve2Cmd	0	SysBusAmps12Sens	13.4	MRAct2PosCmd	0.075	FuelReturnOn	0x00	val9	1902...	MMonFwd1	288...
val100lTotalFlow	13.562	Accel_1TailY	0.954	EngFuelValve3Cmd	0	SysBusVolts28Sens	27.6	MRAct3PosCmd	0.285	SelectedRack	0	OptInBool	0x00...	MMonFwd2	186...
EngCoolantInTempSens	178....	Accel_3AvxX	-0.502	EngFuelValve4Cmd	0	SysBusAmps28Sens	24.2	TRActPosCmd	1.501	VertVelocAck	0.000	OptInInt0	0x00...	MMonRight0	-185...
EngCoolantOutTempSens	186....	Accel_4AvxY	0.301	EngFuelValveDCmd	0	SysBusHVoltSens	263.4	RudderActPos...	2.600	FwdVelocAck	50.142	OptInInt1	0x00...	MMonRight1	-185...
EngCrankPressSens	-0.0	Accel_5AvxZ	0.999	=Navigation & A...		SysBusHWAmpsSens	5.3	MRAct1PosSens1	-0.113	RightVelocAck	0.000	OptInInt2	0x00...	MMonRight2	-205...
IntercoolerOutTempSens	69.300	Accel_6MRGBX	0.371	FwdVelocSens	49.873	ULSigStr1Sens	0.0	MRAct2PosSens1	0.075	HdgVelocAck	0.000	OptInInt3	0x00...	MForceFwd0	186...
EngRailFuelPressSns	59.253	Accel_7MRGBY	-0.017	RightVelocSens	0.250	ULSigStr2Sens	0.0	MRAct3PosSens1	0.289	MRRPMAck	70.079	OptInFloat0	0.000	MForceFwd1	0.000
EngFuelTempSens	97.1	Accel_8DriveshaftZ	0.291	VertVelocSens	-59.000	ULHealth1Sens	254	TRActPosSens1	1.508	EngModeAck	0.000	OptInFloat1	0.000	MForceFwd2	0.000
TailVDTTempSens	121....	Accel_9LeftGear	-0.206	LatitudeSens	34° ...	ULHealth2Sens	254	RudderActPos...	2.555	GBoxModeAck	1	OptInFloat2	0.000	MForceRight0	-185...
OutsideAirTempSens	47.860	FwdAccelSens	-15.235	LongitudeSens	117° ...	DasTempSens	59.7	LandingGearRe...	-0.887	MonModeAck	0	OptInFloat3	0.000	MForceRight1	0.000
TRChipSens	0	RightAccelSens	9.800	VertPosSens	3996...	NSUStatus1	0x080...	RightGearRetr...	-0.892	IgnitionAck	1	Misc_Nyb_...	0x0	MForceRight2	1639...
MRBoxChipSens	0	VertAccelSens	-19.200	IndAirspeedSens	32.597	NSUStatus2	0x010...	LandingGearDo...	-0.123	StartAck	0	m_bCtrlSys...	0	GBStrain0	2.379
EngChipSens	1	LeftGearLoad	-11.500	AttackAngSens	0.003	NSUStatus3	0x000...	RightGearDoor...	-0.105	ActTestAck	0	m_bCtrlSys...	1	GBStrain1	7.787
=Main Rotor=		RightGearLoad	23.125	SideslipAngSens	0.003	NSUStatus4	0x023...	LeftBrakeAmp...	6.992	AbortAck	0	m_bCtrlSys...	0	GBStrain2	0.000
CollectiveSens	3.324	=Engine=		RadarAltSens	1052...	NSUStatus5	0x000...	RightBrakeAmp...	17.917	OnGroundAck	1	m_bCtrlSys...	0	=EXCITED...	
CollectiveCmd	3.256	EngThrottlePosCmd	43.811	EastWindSens	-20.427	NSUStatus6	0x000...	WastegateAm...	-0.255	ManualButt...	1	m_bCtrlSys...	0	ProgSigStamp	3011...
CyclicFwdSens	1.903	EngThrottlePosSens	37.6	NorthWindSens	-4.964	NSUStatus7	0x000...	EngThrottleAm...	1.852	AutoButton...	0	m_bCtrlSys...	0	ProgSigPhase	0.000
CyclicFwdCmd	2.000	WastegatePosCmd	89.912	TrueAirspeedSens	34.695	NSUStatus8	0x000...	MRAct1TempS...	77.400	ForcelostLi...	0	m_bCtrlSys...	0	ProgSigFreq	0.000
CyclicRightSens	-3.175	EngWastegatePosSens	89.953	RollRateSens	-11.700	NSUStatus9	0x000...	MRAct2TempS...	76.800	VertVelocAuto	0.000	LaserDist0	0.000	MForceSigAmp	0.000
CyclicRightCmd	-3.196	O2_2Sens	14.425	PitchRateSens	0.880	NSUStatus10	0x000...	MRAct3TempS...	82.700	FwdVelocAuto	0.000	LaserDist1	0.000	ProgSigOffset	0.000
MRAzimuthSens	339....	Alternator1TempSens	162....	YawRateSens	1.700	NSUStatus11	0x000...	TRActTempSens	106....	RightVeloc...	0.000	LaserDist2	0.000	ResponseGain	0.000
MRMastMonFwdSens	230....	Alternator2TempSens	156....	RollAltSens	9.690	NSUStatus12	0x000...	Act3RateTemp...	86.400	HdgRateAuto	0.000	=Raw Str...		ResponseP...	0.000
MRMastMonRightSens	240....	EngExhaustGas1TempS...	1325.1	PitchAttSens	0.580	Pwr28VTempSens	99.800	=Operator In...		=Spare Se...		MStrain0_0	8056	ResponseS...	0.000
MRBlade15FlapStrainSe...	99.184	EngExhaustGas2TempS...	1290.5	HdgAttSens	121....	Pwr12VTempSens	88.700	MRRPmpc	69.934	CtrlSpare3...	-2.000	MStrain0_1	7135	ProgSignal_0	1642...
MRBlade15LagStrainSens1	-400....	EngExhaustGas3TempS...	1315.3	HdgRateSens	3.180	PwrRectTempSens	85.150	VertVelocIn	0.0	CtrlSpare4...	-7.515	MStrain0_2	5504	=GAINDO...	
MRHubLagStrainSens1	1025....	EngExhaustGas4TempS...	1308.8	HomeLatitude	34° ...	SmallActBoxTemp...	74.800	FwdVelocIn	0.0	VehicleWei...	3132...	MStrain0_3	16383	gain1	1.000
MRHubFlap1StrainSens1	486....	EngExhaustGas5TempS...	1793.8	HomeLongitude	117° ...	tFlkPhase_Mode	07	RightVelocIn	0.0	VehicleCGS...	0.000	MStrain1_0	0	gain2	1.000
MRHubFlap2StrainSens1	663....	EngExhaustGas6TempS...	1793.8	MarkLat	34° ...	tStatusWarn	0	HdgVelocIn	0.0	MonSpare2...	0.000	MStrain1_1	0	gain3	8.000
MRHubFlap3StrainSens1	32.044	EngTurboInletTempSens	1711.8	MarkLong	117° ...	tValTooLowWarn	0	MRRPMin	0.0	MonSpare3...	0.000	MStrain1_2	0	gain4	0.000
MRHubFlap4StrainSens1	1251....	EngTurboOutletTempSens	1278.7	FromLat	0° ...	tValTooHighWarn	0	EngModeIn	0	MonSpare4...	0.000	MStrain1_3	0	gain5	0.000
MRPitchLink1StrainSens1	165....	LeftBlanketTempSens	116....	FromLong	0° ...	UpSigStr1	99.997	GBoxModeIn	0	OilAltTurbo...	0.000	MStrain2_0	8091	gain6	0.000
MRPitchLink2StrainSens1	121....	IntercoolerInTempSens	1711.8	ToLatitude	0° ...	UpSigStr2	99.997	MonModeIn	0	EngSpareT...	0.000	MStrain2_1	8493	gain7	0.000
MRPitchLink3StrainSens1	81.025	L2RadTempSens	1793.8	ToLongitude	0° ...	UpSigStr3	0.000	m_bVertAlt	0	Thermococ...	1436...	MStrain2_2	10765	gain8	0.000
MRPitchLink4StrainSens1	124....	StarterTempSens	95.335	GcsLatitude	34° ...	DnSigStr1	48.400	m_bHorzAlt	0	MonAD63	-0.000	MStrain2_3	8064	gainBase	24
GBoxOilTempSens	143.5	Fan1SpeedSens	2330...	GcsLongitude	117° ...	DnSigStr2	45.000	IgnitionIn	0	ControlRev	0x01...	MStrain3_0	4961	=GAINUP...	
GBoxOilPress1Sens	30.1	Fan2SpeedSens	996....	GcsVertPos	2855...	DnSigStr3	0.000	LandingGearCmd	1	ControlX1Rev	0x00...	MStrain3_1	3583	gain	0.000
GBoxOilPress2Sens	113....	Fan2SpeedSens	996....	DishAzimuth	0.000	UpHealth1	254	GearDoorCmd	0	MonitorRev	0x01...	MStrain3_2	2969	gainD	0
GBoxOilFlowSens	1.160	EngFan1AmpsSens	5.566	CurLatitude	34° ...	UpHealth2	254	TailFairingCmd	0	MonitorX1Rev	0x00...	MStrain3_3	8618	=SUBSYS...	
GBoxPumpAmpSens	1.622	EngFan2AmpsSens	1.427	CurLongitude	117° ...	UpHealth3	1323	StartIn	0	MiscStatus1	0	CStrain0_0	7902	validEngLp	10
GBoxRadPlenmPress	-0.000	Fan1TempSens	79.800	VertVelocMin	-504....	DnHealth1	254	ActTestIn	0	MiscStatus2	1	CStrain0_1	7955	EngMBEUp...	????...
GBoxSparePressSens	-0.000	Fan2TempSens	90.800	FwdVelocMax	149....	DnHealth2	254	AbortIn	0	MiscStatus3	0	CStrain0_2	7786	validRTCM	0
SwashplateTempSens	133....	RadFan1TempSens	66.500	FwdVelocMin	-14.975	DnHealth3	245	OnGroundIn	0	MiscStatus4	294	CStrain0_3	7786	RTCM_104...	
GBoxCaseTemp1Sens	133....	RadFan2TempSens	58.750	RightVelocMax	-29.925	DGP5	1	ManualButtonIn	0	MiscStatus5	0	CStrain1_0	7763	ecuPot0	2.250
GBoxCaseTemp2Sens	146....	EngFan1Cmd	2.382	RightVelocMin	-29.925	GPS	1	AutoButtonIn	0	MiscStatus6	0	CStrain1_1	7907	ecuPot1	0.124
=Tail Rotor & Ruddy...		EngFan2Cmd	1.000	HdgRateMin	-24.375	=Actuators=		ForcelostLinkB...	0	MiscStatus7	0	CStrain1_2	7509	ecuPot2	0.102
TailSens	2.508	FuelLevel1Sens	22.115	HdgRateMax	24.375	MRAct1AmpSens	0.360	Misc_Bits	0x0	MiscStatus8	0	CStrain1_3	7759	=SUBSYS...	
		FuelLevel2Sens	9.325			MRAct2AmpSens	0.162	LandingGearUp	0	MiscStatus9	3009...	CStrain2_0	7981	validEngDn	10