

# ALFRED E. MANN FOUNDATION



## Medical Electronic Products

Prepared for the ISART Panel on Sharing Radar Bands with  
Commercial Systems

7/29/11

# IMPLANTED MEDICAL DEVICES

- Make the deaf hear, the lame walk, and the blind see
  - Pacemakers (Pacesetter/Siemens)
  - Cochlear implant (Advanced Bionics)
  - Microstimulators (AEMF, Boston Scientific, USC)
  - Retinal Implant (2<sup>nd</sup> Sight)
  - Insulin pump/Artificial pancreas (Mini-Med/AEMF)
- Near-field magnetic induction and short-range RF power and serial data channels optimized for the specific application



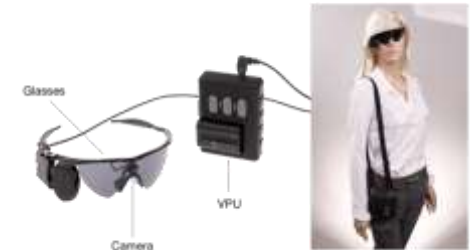
Spinal Cord Stimulator



Cochlear Implant



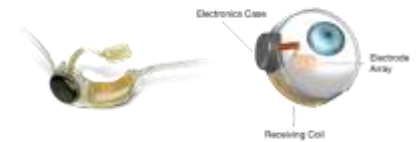
Insulin Pump



Glasses

Camera

VPU



Electronics Case

Electrode Array

Receiving Coil

Retinal Implant

# BODY-AREA COMMUNICATIONS

- Prosthetic devices have different needs than the more conventional body area network (BAN) for transmitting medical information and present unique communications requirements for each type of device
- Limit the distance of operation
  - Implanted devices are close to their external system elements
  - Reduce co-site interference (other patients and other systems) [Example: MICS]
  - Extend battery operating time [Example: Bluetooth Low Energy Special Interest Group]
- Sensory replacement devices generally require continuous operation
  - Higher duty-cycle, higher data rate communication
  - Require frequent battery recharging
- Body tissues attenuate RF and drive applications to lower frequencies and shallow implantations
- Induction links reduce available system bandwidth
- These unique RF applications differ from the usual regulatory concepts developed for conventional radio usages
- Whenever feasible use commercially available compliant links to communicate from the body to off-body ports (MICS, Bluetooth, Ant, Zigbee, etc.)

# MMN EMISSIONS AND RADAR



ISD

MCU

Table 4-1. Largest Required Separation Distances from AMF into Environment

- MMN (Medical Micropower Network) operates on four 6MHz wide channels at 416, 428, 441, and 458MHz continuously polling ISD's (Interacting System Devices) at a ~50Hz rate with a 0dBm transmit level (Under 27 CFR 2.106 Footnote US7 amateur band 420-450MHz is limited to 50W even in restricted areas)
- Typical applications use 2-12 ISD's
- The MCU (Master Controller Unit) uses frequency excision to avoid occupied channels in order to minimize external interference and to enhance internal error rate
- For the calculation of RSD the INR=-6dB such that a 1dB reduction in sensitivity is induced in the C-E RX
- Active frequency excision of the MCU further reduces the calculated interference on incumbent radars

AMF as TX Government C-E System as RX		RSD (Outdoor)				RSD (Indoor)			
		MCU PL(50%) (km)	ISD PL(50%) (km)	MCU PL(95%) (km)	ISD PL(95%) (km)	MCU & Bldg PL(50%) (km)	ISD & Bldg PL(50%) (km)	MCU & Bldg PL(95%) (km)	ISD & Bldg PL(95%) (km)
Land Mobile	Base	0.31	0.04	0.30	0.02	0.30	0.01	0.30	0.004
	Mobile	0.30	0.04	0.23	0.02	0.18	0.01	0.12	0.004
Mobile	Base	0.34	0.04	0.30	0.02	0.30	0.01	0.30	0.004
	Mobile	0.30	0.04	0.25	0.02	0.20	0.01	0.12	0.004
Aeronautical Mobile	Base	0.34	0.03	0.30	0.01	0.30	0.01	0.26	0.003
	Air	1.34	0.02	0.53	0.01	0.34	0.004	0.13	0.002
Maritime Mobile	Base	0.30	0.02	0.30	0.01	0.25	0.004	0.12	0.002
	Mobile	0.30	0.01	0.26	0.004	0.10	0.003	0.06	0.001
Radiolocation	Ground Station	0.70	0.12	0.41	0.05	0.32	0.03	0.30	0.01
	Mobile Air	5.98	0.08	2.38	0.03	1.50	0.02	0.60	0.01
	Mobile Ground	0.29	0.02	0.18	0.01	0.15	0.01	0.09	0.002
No Specific Service (Experimental)	Base	0.37	0.06	0.30	0.03	0.30	0.02	0.30	0.01
	Mobile	0.31	0.07	0.30	0.05	0.30	0.03	0.21	0.01
Fixed		0.52	0.09	0.31	0.04	0.30	0.02	0.30	0.01
Space Research (Space-to-Space)		No Records	No Records	No Records	No Records	No Records	No Records	No Records	No Records
50% to 95% difference of 8 dB									
Bldg - Suburban Building Loss of 12 dB used in analysis RX - Receiver TX - Transmit									

# WIRED MMN SUSCEPTIBILITY AND EXCISION TESTING

- Performed to determine the capability to excise channels and dynamically change channels without affecting critical functions
- Used synthesized formats to represent ground and airborne radars, mobil voice and data radios, television, and Enhanced Position Location Reporting System
- MMN successfully operated in the presence of all allocated spectrum users in the range 413-456MHz
- In the presence of airborne radar the MCU initiates channel change in the region -52 to -57dBm received signal strength
- FM and FSK signals initiate channel change at -60 to -63dBm

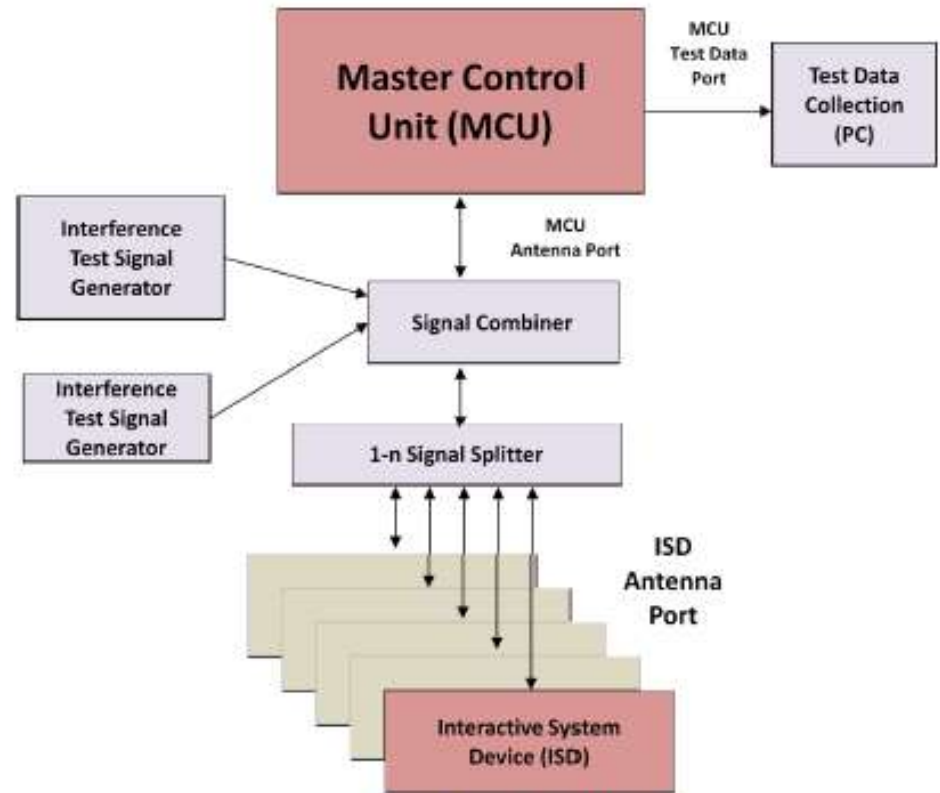


Figure 2. Wired model of MMN.